EFFECTS OF CEMENT DUST ON THE HEMATOLOGICAL PARAMETERS IN OBAJANA CEMENT FACTORY WORKERS

Emmanuel, T.F.
Department of Medical Biochemistry. Faculty of Medicine,
Kogi state University, Anyigba, Nigeria
Ibiam,U.A.
Department of Biochemistry, Faculty of science,
Ebonyi State University, Abakaliki, Nigeria
Okaka, A.N.C.
Department of Biochemistry, Anamdi Azikwe University Awka, Nigeria
Alabi, O.J.
Department of Community Medicine,
Kogi State University Teaching Hospital, Anyigba, Nigeria

Abstract

This study investigated effects of cement dust on haematological parameters of Obajana Cement factory workers. The investigation of haematological parameters were performed on 60 workers in different units/sections exposed to cement dust and controls (unexposed to cement dust). Automated Abascus Haematoanalyser was used to analyse haematological indices. The results showed that the values of white blood cell (WBC), lymphocytes (LYM), monocytes (MID), haematocrit (HCT), mean corpuscular haemoglobin (MCH), mean corpuscular heamoglobin concentration (MCHC) and platelets (PLT) were significantly increased in exposed workers but red blood cell (RBC) and Haemoglobin (HGB) were significantly lower($p < 0.05$). Results also showed a long term duration response effect on the Haematological indices in relation to years and age of workers of exposed to cement dust. In this study alteration in level of haemotological parameters in exposed workers is an indication of effect of cement dust on pathopysiology of blood and reticuloendothelia system of cement factory workers and in general human health. This study highlighted the need for continuous cement dust environmental monitoring, mandatory use of personal protective equipment and periodic haematological assessment of factory workers to prevent related haematological hazard.

Keywords: Blood, Exposed and Unexposed workers, cement dust exposure, Haematological indices, pathophysiology, reticuloendothelia

Introduction

The total world cement production was 1352 million tones in 2013 and is expected to be around 4.4 billion metric tones in 2020. As at December 2010, there were over 190 production plants in Africa. It has been identified that the global cement majors such as Lafarge, Holcim, Heidelberg cement and Ital cement controls about 45 percentage of African's installed capacity. Dangote cement is Africa's leading cement producer with three plants in Nigeria and plans to expand in 13 other African countries. The group has a production capacity of 30 million tones in Nigeria and operational plans to have 60 million tones (MTS) of production, grinding and import capacity in Sub- Saharan Africa by 2016.

Obajana cement PLC was incorporated by the Kogi State Government in 1992. It was however acquired by Dangote industries limited in 2002 and commenced construction of the first cement Plc to Dangote Cement Plc in July, 2010. The cement plant is sited in Obajana village, on 4.4 hectares of land allocated to Obajana cement Plc by the government of Kogi state. The site is a relatively flat terrain, originally bearing a Guinea savannah vegetation type. The housing colony is sited about a kilometer away from the Obajana cement plant site on a land originally belonging to Oyo-Iwa community, in Lokoja L.G.A of Kogi State.

The cement plant is a green field cement plant initiated in 2003 and commissioned in 2007 with an annual capacity of 5 million tones and now the largest cement factory in Africa with 10.25 metric tones capacity across three production lines and a further 3 metric tones capacity currently being built. The cement plant comprise a cement plant, limestone quarry, 35Mw captive power plant, 90km natural gas pipeline and 351 unit housing complex for staff , earth dam water reservoir and 500 trucks for cement transportation (Vetiva, 2010).

Cement is manufactured from 4 major components, limestone, latrites, clay and gypsum(Amodu AE and Egwuogu, 2014). The first three components are gotten from operational processes called quarry in operations. In most cases, the rocks are fractionated to small particles sizes known as quarry fines. Further treatment is employed to convert the fines particles into the powder form known as quarry dust. Cement is a dark grey colored powdery substance of alumina, silica, lime, iron oxide and magnesium oxide. Cement industry is reported to have socio-cultural, economic and health implications on the people, communities and the Nation(Musa and Kpanache, 2014; Meo *et al.*, 2002; and Nwaiselage *et al.*, 2005). The production of cement leads to the production of cement dust of which the workers are exposed to daily. A single and short term exposure to cement dust presents with little or no hazard. However prolonged or repeated exposure depending on the duration, level of exposure and individual sensitivity have health implications on the skin, eye, respiratory and haematolgical systems Osaro et al., 2013; Jagadishnaik, 2012;Jude *et al* ., 2002 ; John and Olubayo , 2011). The hazardous materials in cement include alkaline compounds such as lime(calcium oxide) that are corrosive to human tissue, crystalline silica which is abrasive to the skin and damage the lungs and chromium that causes allergic reactions (Meo,2004; Syed *et al* ., 2013). Cement causes skin dryness, discomfort, irritation, dermatitis and burns due to its caustic, abrasive and drying properties (Bour *et al*., 2011). Some workers become allergic to the hexavalent chromium in the cement with the development of symptoms ranging from a mild rash to severe skin ulcers. Airborne cement dust may cause immediate or delayed inflammation, eye irritation, abrasion, red eye, chemical burns and blindness. Inhalation of cement dust may occur when workers empty bags of cement. In short term, such exposure irritates the noise and throat and cause choking and difficult breathing. The sanding, grinding or cutting processes in cement production releases a large amounts of cement dust which contains high level of crystalline silica and prolonged exposure can lead to silicosis (Kakooei et al., 2012). Some studies (Susan,2009;Syed et al., 2013) indicated a link between crystalline silica exposure and lung cancer. Silicosis increase the risk of tuberculosis. Individuals with lung diseases such as bronchitis, emphysema, chronic obstructive pulmonary disease can be aggravated by cement exposure(Ahmed and Abdullah, 2012). The hexavalent chromium content of cement have been implicated as the aetiology of allergic occupational asthma that was developed by cement factory workers. Some studies showed an increase incidence of chronic kidney disease and end stage renal disease in workers exposed to respiratory crystalline silica. Studies(

Sultane et al., 2002; Okonkwo et al., 2015) have shown that cement dust have deleterious consequences on haematological indices of human exposed to the dust. In their findings Divya and Suja (2002) reported that cement workers exposed to cement dust have decrease in red blood cell (RBC) which may due to responses of body to irritation (Mojiminiyi, 2008), higher white blood cell (WBC) which may be due to irritant cement dust particles deposited in the lungs, increase in lymphocytes count and decrease monocytes count, increase in platelets count which are sign of stress response which lead to RBC swelling or haemoconcentration plasma volume reduction (Wilson, 1993) as a result of cement dust, a decrease in haemoglobin concentration and packed cell volume (PCV) which is a sign of anaemic condition (Calistus *et al*., 2002), an increase in mean corpuscular volume (MCV) which may be due stimulation of erythropocesis, increased in platelets (PLT) due to excess production of haematopoietic regulatory elements such as colony stimulating factors, erythropoietin and thrombopoietin by the stromal cells and macrophages in the bone marrow (Amin *et al*., 2004), increased in MCH due to structural damage to red blood cell membrane resulting in haemolysis synthesis, stress related of RBC from the spleen and hypoxia (Shah, 2006). Decrease in mean corpuscular haemoglobin concentration (MCHC) reported by Isselbacher *et al*., (1992) may be due to impairment of biosynthesis of heme in bone.

Mojiminiyi (2008) found that fall in haemoglobin packed cell volume, red blood cell (RBC) which were also in agreement of findings reported by Jude *et al* (2002) earlier and rise in white blood cell count, platelet count, significant increase in lymphocyte count suggest cement dust may have a harmful effect on the bone marrow, the source of these cells according to Mojiminiyi (2008). Pre-employment and periodic medical examinations of factory workers promotes optimum health. Medical examination include detail history taking, physical examination and investigations. Haematological examination include full or complete blood count (FBC), packed cell volume(PCV), haemoglobin(Hb), mean corpuscular volume(MCV), mean corpuscular haemoglobin(MCH), mean corpuscular haemoglobin concentration(MCHC), reticulocyte count, total and differential white blood cell count (WBC), and platelet count.Omotosho et al., 2012; Asogwa, 1979 and Louis, 1998 advocated strategies such as environmental monitoring, hazard awareness and educational campaign, wearing of personal protective equipment, safety practices and medical examination toward achieving occupational health and safety in cement factories. The objective of study was to assess the haematological profile as a maker for monitoring the effects of cement dust on Obajana factory workers.

Materials and methods

Materials

Equipments

Major equipments used are: Agilant Spectrophotometer,S800 Diode Array Spectrophotometer, Abascus Junior Haematology Analyser 2.75 (Diatro Count 3 Haemology EC Diatron, MJ PCC, Hungary). Glasswares,

Chemicals and reagents

All chemicals and reagents were of analytical grade.

Study groups

The study subjects were of those selected workers working in the units/sections mostly exposed to cement dust of Obajana cement factory which included: crusher, kiln, milling, bagging and loading and units/ sections. The selection was based on levels of exposure (Alakija *et al.*, 1990; Mwaiselage *et al.*, 2005). Fifty suitable workers in these units/sections were used in the work. They had been working and exposed to cement dust for 2 - 10 years. Ten workers as an unexposed group as control who are matched by age, and socio - economic class with workers from units/sections (exposed group). The unexposed groups are workers that reside about 20 kilometers away from Obajana cement factory. Workers with no history of respiratory dysfunction, or signs of liver, heart, generic, haematologic and bone diseases, non smoking were only used for exposed and unexposed subjects. However subjects with symptoms of cough and sneezing among workers performing dusty operations were not used for either of the group.

Ethical clearance

Ethical clearance was dully obtained from Department of Research and Development.Ministry of Health ,Lokoja,Nigeria. Written and verbal informed consents were taken from all workers.

Anthropometric parameters

These were done according to the technique described by Manjula *et al*, (2013). Data were collected on general demographic profile; smoking, clinical signs, medical/clinical history. Pretested, semi-structural and interview- administered questionnaires were used for data collection. Clinical examination of workers were also done. The weight and height were taken with stadiometer. The information was collected on the subject as to the use of personal protection apparatus, work environment, hand gloves, dust masks, sound proof earplugs and safety hood, period of (years) of exposure as deduced from date of employment, site / position at workplace, use of safety tools such as dust masks and earplugs e.t.c. Information on general health, history of past disease(s) and habits such as smoking and alcohol consumption were obtained.

Analyses

Blood and blood serum collection.

Five militre (5.0 ml) of blood was collected from each worker with the assistance medical laboratory scientist,Federal Medical centre ,Lokoja, Nigeria.Sample collection was done once in every November for three years.

Analysis of haematological indices

The haematological indices in include: Erythrocytes, Hemoglobin, Haematocrit, Leukocytes, lymphocytes, Monocytes, and Platelets,Haemoglobin estimation (Hb), mean corpuscular hemoglobin (MCH, Mean corpuscular volume (MCV) , white blood cell (WBC), Packed cell volume (PCV) Red blood cell (RBC) determination was according to the technique described by Baker and Silverton, (1985) using Abascus Junior Haematology Analyser 2.75 (Diatro Count 3 Haemotology EC Diatron, MJ PCC, Hungary).

Statistical analysis

All data were stated as mean ±SD and ANOVA was used to analyse the data using Graph Pad Instat - [DataSet 1.LSD] package. Least Significant Difference (LSD) was applied to determine the significance of the difference at P<0.05 and 95% confident interval.

Results

Sixty (60) factory workers of Obajana cement factory were studied. The mean age of workers as showed in table 1 was 33.4 ± 14.0 years. The mean height and weight of the workers were 1.62 ± 0.05m and 64.7± 6.27kg respectively. The mean time of daily exposure was 9.2± 2.35 hours while the mean years of exposure was 5.29± 1.73 years. In table 2 and 3 below the value of white cell count, lymphocyte, monocytes, mean corpuscular haemoglobin and platelets were significantly increased in cement exposed workers (p< 0,05), while red blood cells, granulocytes and haemoglobin were significantly lower P<0.05. The observed increases in monocytes count and the differences in the haemotocrit and the mean corpuscular haemoglobin concentration were statistically insignificant (p< 0,05) .

Discussion

The WBC and PLT were significantly higher in several of workers in Lw than those workers that are not exposed to cement dust (unexposed group). The rise in WBC and PLT cells count perhaps suggest a response to toxic effect of cement dust inhaled into the lungs (Mojiminiyi *et al* 2008). The observed lowered HGB and HCT and raised WBC and PLT in several of exposed workers in Kw and Lw suggest that cement dust exposure may have a deleterious effect on the bone marrow, the source of these cells (Mojiminiyi *et al,* 2008). Significant different noted in GR and GRA between the exposed and unexposed workers are in accord with the finding of Jude et al,(2002). However, slight decreased in RBC was noticed and this may be due to secondary reactions of an organism to toxic substances (Rogers and Wood, 2003). Increased in lymphocyte of workers in Kiln

(Kw) and monocytes count in exposed were significant. This difference may be due to variation in varied in the number of year the workers worked in of cement dust area (Pond *et al.,* 1982) . Increase in platelet counts are sign of stress response which lead to red blood cells (RBC) swelling or haemo-concentration plasmatic volume reduction (Wilson and Taylor, 1993). A decreased in haemoglobin concentration and PCV in the blood samples of some exposed group in some units is a sign of anaemic condition (Calistus *et al.,* 2002).

Increased in MCH noticed in some units may be due to structural damage to RBC membrane resulting in haemolysis production, stress related, RBC from the spleen and hypoxia (Shah , 2006; Dier , 2014). Also, decreased in MCHC though insignificant in this study but have been attributed to impairment of biosynthesis of heme in bone marrow (Isselbacher, 1992). The haemoglobin (HGB), RBC, of exposed workers cement dust were significantly decreased compare to those unexposed. The decreased in levels of these parameters may be due to exposure factors other than dietary deficiency as both exposed and unexposed workers used in this work were matched by socio-economic status (Khaled, 2004) though slight differences still existed. In addition to this, both exposed and unexposed workers were not significantly different in weight. Thus, the reduced haemoglobin , RBC and granulocytes probably suggest a response to the toxic substances from cement dust by body organs as reported by Khaled (2004).

Increased in WBC, lymphocyte (LYM), monocyte count were significant in workers exposed to dust for 1-4, 5-8 and 9-12 years and this is clear indication that the more year of exposure to cement dust may increase the level of WBC disruption in the body.

Conclusion

Based on the aforementioned results we concluded that workers of Obajana cement factory exposed to cement dust:-

1. The haematological indices showed significant increased in WBC, PLT, LYM, MCH, and decreased in HGB, granulocytes, RBC, indicating toxic effect of the cement dust on the workers.

2. The observed differences in the monocytes count, haemotocrit and mean corpuscular haemoglobin concentration between the exposed and unexposed cement factory workers were statistically insignificant in this study.

3. This study underscore the need for continuous environmental monitoring, use of personal protective equipments and medical examination of factory workers to promote health and safety at work.

References:

Ahmed, H.O., Abdullah, A.A (2012). Dust exposure and respiratory symptoms among cement factory workers in the United Arab Emirates. Indian Health. 50(3); 214-222.

Alakija, W., Iyawe, V. I., Jarikre, L. N. and Chiwuzie. J. C. (1990). Ventilator function of workers at Okpella cement factory in Nigeria. *West Africa Journal of Medicine* **9**(3): 187-193.

Amin, M. A., Amin, A. P., Kulkaini, H. R., (2004). *Annual Journal of Haematology*. 83(6): 331-335.

Amodu, A.E., Egwuogu, C.P. Elemental characterization of Obajana Limestone deposit using energy dispersive x-ray fluorescence(XRF) technique. Journal of Applied Science and the Environment; 65-68.

Asogwa,S.E(1979). A guide to occupational health practices in developing countries. Fourth Dimension publishers. Enugu. Nigeria; 1- 162.

Bour J.W, Juyn D.W., Shiann, C.S., Tung, S.S, Ho-Yuan, C, Yue, L (2011). Occupational hand dermatitis among cement workers in Taiwan. Journal of the Formosan Medical Association.110(12) ; 775-779.

Calistus J. A. L., Sasikala K. R., Ashok Kumar S., Sudha and Raichel L. (2002). *International Journal of Human Genetic***2**(2): 95 – 99 No title of work

Dier, M.S., Sirwan M.M., Logman, O.H.S (2014). Some biochemical and haematological parameters among petroleum and cement factory workers in Sulaimaniyah city/ Kurdistan/Iraq. Chenistry and Materials Research.6(8); 29-33.

Divya, P.S. and Suja, S. (2002). The effect of cement dust exposure on haematological and cytogenetic studies of cement workers. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*. 2(2): 95-99.

Isselbacher, K. I., Braunwald, E., Wilson, J. D. (1992). Harrison's principle of internal medicine. New York McGraw-Hill.

Jagadishnaik M(2012). The effect of cement dust exposure on haematological parameter of cement factory workers in Nalagonda, Andhra Pradesh. International Journal of Advancements in Research and Technology. 1(5); 46-52.

John O and Olubayo M (2011). Biochemical and haemato;ogical profile in Nigerian cement factory workers. Research Journal of Environmental Toxicity. 5; 133- 140.

Jude C. A. L., Sasikala K., Ashok, R., Sudha S., Raichel J. (2002). Haematological and cytogenetic studies in workers occupational exposed to cement dust.*International Journal of Human Genetic*. **2**(2): 95-99.

Kakooei H, Gholami A, Ghasemkhani M, Hosseini M, Panahi D, Pouryaghoub G(2012). Dust exposure and respiratory health effects in cement production. Acta Medicine, Iran. 50(2); 122-126.

Khaled, S. A. S. (2014). Assessment of oxidative stress, haematological, kidney andliver function parameters of Libyan cement factory workers.*Journal of American Science* **10**(5): 58-64.
Louis J D. Handbook of occupational safety and health. Wiley–Interscience publisher.2nd Edition. 1998; 1- 1224.
Manjula, R., Praveena, R., Clevin, R. R., Ghattargi, C. H., Dorie, A. S., Lalitha, D. H. (2013). Effect of occupational dust exposure on the health status of Portland cement factory workers. *International journal of medicine/public health.* **3**: 192 -196
Meo, S.A., Azeem, M.A., Ghori, M.G., Subhan, M.M (2002). Lung function and surface electronmyography of intereostal musles in cement mill workers. I*nternational. Journal ofoccupational Medicine and Environmental Health* 15(3):279-287).
Meo S.A(2004). Health hazards of cement dust. Saudi Medical Journal. 25; 1153-1159.
Mwaiselage, J., Bratveit, M., Moen, B.and Yost, M. (2005). Variability in dust exposure to dust on lung function of cement factory workers. *Medical journal of Malaysia* **55** (2): 51 – 57.
Mojiminiyi, F. B. O., Merenu, I. A., Ibrahim, M. T. O. and 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): 111-114.
Musa D, Kpanache D(2014). The impact of Obajana company as a growth pole in Obajana, Kogi State, Nigeria. Ethiopian Journal of Environmental Studies and Management. 7(1);73-81.
Okonkwo, C.O.J., Ugwu, C.E., Anakor, A.C.F., Dike, C.C,, Nwobodo E (2015). The effects of cement dust on haematological parameters of cement workers in Asaba, Delta State, Nigeria. Journal of Environmental Science, Toxicology and Food Technology. 9(1);05-08.
Omotosho, M., Bamidele J., Saludeen A., Saromi H., Ade omi, A.A (2012). Occupational hazard awareness and safety practices among cement factory workers at Obajana, Kogi State, Nigeria. Elixir Bio Diverty. 47; 9013-9018.
Osaro E., Kebbe, B.I., Isaac, I. Z, Nasiru A., Marafa, Y., Augustine, N.O(2013). Effect of occupational exposure of cement dust on some haematological parameters of workers in a cement company in Sokoto, Nigeria. InternationalJournal of Medical Science and Health 1(7); 21-25.
Pond, W. G., Yen, J. T., Hill, D. A., Ferrell C. L. and Krook, L. (1982). Bone lesions in growing swine feed 3% cement kiln dust as a source of calcium. *Journal of Animal Science*.**54**(1): 82 - 88.
Rogers J. T. and Wood C. M. (2003). *Aquatic Toxicology***64**(2): 215 – 34.
Shah S. L. (2006).Toxicology of cement dust. *Journal of Applied Toxicology***26**(3): 223 - 228.

Sultane, A.M., Muhammed, A.Z, Shoukate, A.A., Merza, M.S(2002). Haematological changes in cement mill workers. Saudi Medical Journal. 11; 1386- 1389.

Susan, P., Yingvar, T,, Edetraud, F., Hans, K. (2009). Personal exposure to inhalable cement dust among construction workers. Journal of Environmental Monitoring. 11; 174- 180.

Syed, S., Bhat, G A., Henah, M.B(2013). Health risks associated with workers in cement factories. International Journal of Scientific and Research Publications. 3(5); 1-5.

Syed, S.M., Bhat, G.A, Henah, M.B(2013). Cement factories and human health. International Journal of Current Research and Review. 5(18); 47- 53.

Vetiva (2010). Dangote Cement Plc Initiative of Coverage, Bulletin 22; 1 – 2.

Wilson, R. W., and Taylor, E. W. (1993). The physiological responses of freshwater rainbow trout on corhynchus mykiss during acutely lethal copper exposure. Journal of Comparative Physiology B. 162: 38 – 47

Table: 1 Anthropometric parameter of exposed and control subjects

	AV.Height (m)	**AV.Weight (kg)**	**Age range (year)**	**exposure/ hour daily**	**year of expos(yr)**
Cw	1.61 ± 0.06	66.26 ± 6.02	22 - 55	8.00 ± 0.00	6.30 ± 2.26
Kw	1.63 ± 0.05	63.86 ± 7.67	22 – 55	8.80 ± 2.53	4.50 ± 1.35
Mw	1.60 ± 0.04	64.04 ± 6.06	22 – 55	10.00 ± 2.11	4.26 ± 1.57
Bw	1.63 ± 0.05	64.44 ± 4.30	22 – 55	9.60 ± 3.37	5.70 ± 1.95
Lw	1.62 ± 0.04	65.01 ± 4.58	22 – 55	9.60 ± 3.37	5.70 ± 1.95
Control	1.65 ± 0.04	64.69 ± 9.03	22 – 55	0.00 ± 0.00	0.00 ± 0.00

Key Note:CW = Crusher worker in the factory unit,KW = Kiln workers,MW =milling workers, BW = bagging workers, LW = loading workers and CONTROL = subject far

TABLE 2: Haematological Profile Of Obajana Cement Factory Workers

	WBC	LYM	MID	GRA	MI	GR	RBC	HGB	HCT	MCH	MCHC	PLT	PCT
	10^9 (g/L)	10^9 (g/L)	10^9 (g/L)	10^9 (g/L)	(%)	(%)	10^9 (g/L)	(g / l)	(%)	(p g)	(g / l)	10^9 (g/L)	(%)
C w	5.61 ± 0.97	2.33 ± 0.24	0.62 ± 0.13	3.14 ± 0.55	13.58 ± 0.39	57.19 ± 1.91	4.10 ± 1.41	137.97 ± 18.03	39.45 ± 2.63	33.02 ± 4.53	325.68 ± 11.99	213.94 ± 10.36	0.26 ± 0.06
K w	5.54 ± 1.07	2.65 ± 0.91	0.55 ± 0.17	2.72 ± 0.48	13.77 ± 0.86	60.54 ± 4.86	3.91 ± 0.53	127.29 ± 4.95	41.57 ± 1.48	24.66 ± 2.82	325.15 ± 21.27	274.38 ± 54.41	0.21 ± 0.05
M w	4.22 ± 1.01	2.13 ± 0.20	0.57 ± 0.08	2.75 ± 0.25	14.08 ± 2.65	59.35 ± 6.14	2.72 ± 0.53	137.21 ± 15.24	44.86 ± 6.21	34.49 ± 5.78	342.93 ± 90.10	304.14 ± 11.06	0.30 ± 0.08
B w	5.81 ± 1.86	1.84 ± 0.64	0.57 ± 0.16	2.49 ± 0.67	14.50 ± 3.38	44.98 ± 29.30	2.91 ± 0.91	130.21 ± 6.43	44.07 ± 6.91	30.10 ± 3.02	340.66 ± 3.36	301.09 ± 3.45	0.17 ± 0.07
L w	5.97 ± 1.06	2.01 ± 0.25	0.61 ± 0.15	2.36 ± 0.17	13.31 ± 1.77	60.01 ± 5.75	3.25 ± 0.78	120.42 ± 6.80	40.20 ± 6.75	29.28 ± 1.36	340.90 ± 9.14	334.36 ± 18.12	0.31 ± 0.05
CONTROL	5.89 ± 0.69	2.30 ± 0.46	0.54 ± 0.23	3.04 ± 0.79	13.46 ± 3.66	55.70 ± 14.17	4.36 ± 1.00	137.94 ± 14.25	43.53 ± 3.94	33.18 ± 4.44	341.55 ± 19.63	219.94 ± 38.56	0.27 ± 0.06
F	28.16	34.33	0.40	3.23	0.33	1.77	5.48	3.54	1.86	11.99	0.46	28.3	6.89
P Value	0.00	0.00	0.84	0.01	0.89	0.14	0.00	0.01	0.12	0.00	0.81	0.00	0.00
DF	59	59	59	59	59	59	59	59	59	59	59	59	59

^{WBC}LSD(0.05) =1.038, ^{LYM}LSD(0.05),=0.460, ^{MID}LSD(0.05) =0.141, ^{GRA}LSD(0.05),=0.48 ^{MI}LSD(0.05) =2.174, ^{GR}LSD(0.05),=12.354, ^{RBC}LSD(0.05) =0.810, , ^{HGB}LSD(0.05) =11.306, ^{HCT}LSD(0.05) =4.542, ^{MCH}LSD(0.05) =3.496, ^{MCHC}LSD(0.05),=34.822, ^{PLT}LSD(0.05) =16.029, ^{PCT}LSD(0.05),=0.056, ^{LY}LSD(0.05) =1.986, (where the mean difference is higher than LSD value then the subject is significantly difference from each other)

Table 3 : Heamatological parameters in exposed and unexposed to cement dust workers in relation to period of exposure

	WBC	LYM	MID	GRA	MI	GR	RBC	HGB	HCT	MCH	MCHC	PLT	PCT
YEAR	10^9 (g/L)	10^9 (g/L)	10^9 (g/L)	10^9 (g/L)	(%)	(%)	10^9 (g/L)	(g / l)	(%)	(p g)	(g / l)	10^9 (g/L)	(%)
`1 – 4	5.39 ± 1.19	2.12 ± 0.52	0.58 ± 0.11	2.68 ± 0.43	13.30 ± 1.50	55.95 ± 12.80	3.15 ± 0.77	128.06 ± 12.69	43.74 ± 5.27	29.54 ± 5.06	328.29 ± 33.76	288.52 ± 48.15	0.24 ± 0.09
`5 – 8	5.39 ± 1.50	2.26 ± 0.64	0.59 ± 0.16	2.72 ± 0.59	14.54 ± 2.15	55.74 ± 15.92	3.53 ± 1.01	132.76 ± 14.27	41.18 ± 5.24	30.81 ± 5.27	340.17 ± 47.57	282.98 ± 48.14	0.25 ± 0.07
`9 – 12	6.07 ± 1.06	2.06 ± 0.29	0.56 ± 0.12	2.52 ± 0.53	11.27 ± 2.11	65.57 ± 12.16	3.57 ± 2.33	128.42 ± 10.04	38.30 ± 8.06	28.27 ± 1.61	334.23 ± 12.33	289.41 ± 68.24	0.28 ± 0.04
CONTROL (0)	5.89 ± 0.69	2.30 ± 0.46	0.54 ± 0.23	3.04 ± 0.84	13.46 ± 3.66	55.70 ± 14.17	4.36 ± 1.00	137.94 ± 15.03	43.53 ± 3.94	33.18 ± 4.44	341.55 ± 19.64	219.94 ± 38.56	