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THE EFFECT OF CEMENT DUST EXPOSURE ON HAEMATOLOGICAL AND LIVER FUNCTION PARAMETERS OF CEMENT FACTORY WORKERS IN SOKOTO, NIGERIA

F. B. O. MOJIMINIYI[1], I. A. MERENU[2], M. T. O. IBRAHIM[2] AND C. H. NJOKU[3]
Departments of Physiology[1], Community Health[2] and Medicine[3], College of Health Sciences, Usman Danfodio University, P.M.B. 2254, Sokoto, Nigeria. E-mail: mojiminiyi@yahoo.co.uk, Tel.: +234-8059538456

Summary: This study measured haematological and liver function parameters in workers occupationally exposed to cement dust in order to test the hypothesis that cement dust exposure may perturb these functions. Assessment of haematological parameters and liver function were performed in 23 workers occupationally exposed to cement dust (mean years of exposure = 9.6± 1.5 years) and 46 matched unexposed controls. The haemoglobin concentration ($P< 0.001$) and packed cell volume ($P< 0.02$) of exposed workers were significantly lower and the platelet ($P<0.01$) and white cell counts ($P< 0.05$) were significantly higher than in the unexposed workers. There was no significant difference in the total granulocyte and lymphocyte/monocyte counts. The liver function parameters remained similar in the exposed workers compared to the unexposed except serum aspartate aminotransferase and alkaline phosphatase activities which were significantly lower ($P<0.05$). These results suggest that occupational exposure to cement dust may perturb haemopoietic function while preserving liver function.
Key words: *Cement dust exposure; haematologic parameters; liver function tests.*

Introduction

Most studies on the effect of cement dust (Alakija *et al*. 1990; Noor *et al*, 2000; Laraqui *et al*, 2001; Al-Neaimi, Gomes and Lloyd, 2001; Meo *et al*, 2002; Mwaiselage *et al*, 2005) or granite dust (Azah *et al*, 2002) exposure in humans have tended to focus on the respiratory system. However it appears that cement dust exposure may affect other systems as well. For instance**,** the cement industry has the highest number of reported cases of dermatitis and conjunctivitis in Nigeria (Ezenwa, 1996) suggesting that cement dust affects the skin and the eyes. The findings of a recent study in India also suggest that cement dust exposure caused haematologic and cytogenetic damage in cement factory workers (Jude *et al*, 2002). Also evidence from experimental animals suggests that cement dust may have deleterious effects on the liver and bone. Specifically, intravenous injection of silica, a major component of cement dust, into the tail vein of rats resulted in large liver granulomas and hepatic silicosis (Kanta *et al.*, 1986) and cement kiln dust fed to pigs to boost dietary calcium resulted in bone lesions (Pond *et al*, 1982).

In the current study we have hypothesized that such liver (Kanta *et al*, 1986) and bone (Pond *et al*, 1982) lesions observed following experimental exposure to cement dust in animals may occur in humans occupationally exposed to cement dust. Should this notion be correct, it is likely that parameters of liver and bone function in cement dust exposed subjects may be different from normal. Consequently this study was designed to test this hypothesis and to confirm the earlier finding of Jude *et al* (2002) on haematologic function. Liver function was assessed by measuring serum liver function tests. Bone function was assessed indirectly by measuring haematologic parameters since blood cells are produced here. This study was carried out in exposed workers of the Cement Factory of Northern Nigeria, Sokoto, Nigeria.

Materials and methods

Sample collection was carried out in the Staff Clinic of the Portland Cement Factory in Sokoto, Nigeria following permission by the factory management and informed consent by the workers. The study population comprised of those working in the cranes, packing, crusher and mill sections of the factory. The workers in these sections were selected because of their high level of exposure (Alakija *et al*, 1990; Mwaiselage *et al*, 2005). Twenty three eligible subjects working in these sections were enrolled in the study. They had been exposed to cement dust for 9.6 ± 1.5 years (Mean ± SEM). An unexposed (control) group consisted of 46 blue-collar workers who were matched by socio-economic class and age with the exposed group. The unexposed group worked and resided 20 kilometers away from the

cement factory in the Sokoto metropolis. Only subjects who were non smokers and who had no history or signs suggestive of respiratory, haematologic, bone or liver diseases were eligible and selected into both the exposed and unexposed groups. However individuals with symptoms common among workers performing dusty operations such as cough and sneezing were enrolled into either group.

Data collection was effected by way of an interviewer-administered structured questionnaire, to determine years of exposure as deduced from date of employment, site or position at workplace, use of safety gadgets 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.

For haematological parameters, 2ml of blood was drawn and placed in bottles containing NaEDTA. Quantitative buffy coat (QBC) machine capillary tubes were used to draw blood from the bottles, mixed by rubbing and spun at 2000 rpm for five minutes. They were then placed in the QBC II machine (Becton Dickinson, Franklin Lakes, NJ, USA) for analyses. The QBC II machine was calibrated before use.

Also, 5ml of venous blood was obtained from each subject, allowed to clot and the serum extracted. The serum was used to estimate the liver function parameters namely: total protein, total and conjugated bilirubin, aspartate aminotransferase, alanine aminotranferase, and alkaline phosphatase using the RANDOX (RANDOX laboratories, Crumlin, Antrim, UK) test kits.

Results are expressed as mean ± SEM. Statistical analysis was carried out using the unpaired student t test. P<0.05 was taken as statistically significant.

Results

A summary of anthropometric parameters and years of exposure of exposed workers and matched controls is presented in table 1. The two groups were similar except that the exposed workers were significantly heavier (P<0.05) and had been occupationally exposed to cement dust for 9.6 ±1.5 years.

The haematological parameters measured are presented in table 2. The haemoglobin concentration (P< 0.001) and packed cell volume (PCV; P< 0.02) of exposed subjects were significantly lower than in the unexposed, while the platelet (P<0.01) and white cell counts (P< 0.05), were significantly higher. There was no significant difference in the total granulocyte and lymphocyte/monocyte counts and neither did the percentages differ between the two groups. The liver function parameters of the subjects are presented in Table 3. All the liver function parameters tended to be lower in the exposed compared to the unexposed except the serum aspartate aminotransferase and alkaline phosphatase levels which were significantly lower (P<0.05) than in the unexposed.

Table 1: Anthropometric parameters and years of exposure to cement dust of exposed workers and matched unexposed controls. Results are expressed as Mean ± SEM.

Parameter	*Subjects*	
	Exposed	*Unexposed*
Age (years)	37.4±1.7	36.5±1.4
Weight (kg)	66.3* ±2.9	62.1±1.5
Height (cm)	172.8±1.6	171.9±0.8
Years of exposure to cement dust	9.6±1.5	-
n	23	46

*P<0.05

Table 2: Haematological parameters of cement dust exposed and unexposed subjects. Results are expressed as Mean ± SEM.

Parameter	*Exposed subjects*	*Unexposed subjects*	*P-value*
Hb (g/dl)	12.1 ± 0.4	14.1 ± 0.2	<0.001
PCV (%)	39.4 ± 1.1	42.6 ± 0.6	<0.02
Platelets ($x10^{9/l}$)	281.9 ±20.3	185.6 ± 5.6	<0.001
WBC ($x10^{9/l}$)	8.5 ± 0.6	7.3 ± 0.2	<0.05
Total granulocytes ($x10^{9/l}$)	4.4 ± 0.5	3.8 ± 0.1	=0.118
Granulocytes (%)	50 ± 2.2	48 ± 0.6	=0.261
Lymphocytes/ monocytes [$10^{9/l}$]	4.0 ± 0.3	3.5 ± 0.1	=0.053
Lymphocytes/ monocytes (%)	51 ± 2.0	52 ± 0.6	=0.545

Hb= Haemoglobin concentration; PCV=Packed cell volume; WBC=White blood cell count.

Table 3: Liver function tests of cement dust exposed and unexposed subjects. Results are expressed as Mean ± SEM

Parameter	*Exposed subjects*	*Unexposed subjects*	*P-value*
Total bilirubin (mg/dl)	0.9 ± 0.1	1.0 ± 0.1	=0.530
Conjugated bilirubin (mg/dl)	0.3 ± 0.05	0.4 ± 0.04	=0.139
Total protein (g/dl)	6.1 ± 0.1	7.4 ± 1.4	=0.516
Albumin (g/dl)	4.3 ±1.6	4.3 ± 1.6	=0.999
Aspartate aminotransferase (U/l)	8.8 ± 0.4	10.4 ± 0.4	<0.05
Alanine aminotransferase (U/l)	6.2 ± 0.5	8.2 ± 0.8	=0.10
Alkaline phosphatase (U/l)	32.9 ± 0.8	53.9 ± 7.2	<0.05

Discussion

The major finding in this study is that chronic occupational exposure to cement dust for 9.6 ±1.5 years may have deleterious effect on haematologic but not liver function. Thus haematological function tests may be useful new parameters in assessing and monitoring the health of cement factory workers in addition to the traditional lung function tests.

The haemoglobin concentration and packed cell volume (PCV) of the exposed workers were significantly lower than those of the unexposed. The reduced haemoglobin concentration and reduced PCV may not be due to nutritional deficiency as both groups were matched by socio-economic status. Besides, the exposed workers were significantly heavier further arguing against nutritional deficiency as a basis for this observation. The white blood cell and platelet counts were significantly higher than those of the unexposed group. The raised white blood cell count probably suggests a reaction to irritant cement dust lodged in the lungs. The observed lowered haemoglobin concentration and PCV and raised white cell and platelet counts suggest that cement dust exposure may have a deleterious effect on the bone marrow, the source of these cells. Indeed, severe bone lesions have been seen in weanling pigs fed cement kiln dust as a way of boosting dietary calcium (Pond *et al*, 1982). It may be interesting to further investigate this.

The present findings on haematologic parameters are in agreement with an earlier finding by Jude et al. (2002) which was probably the first report of its type. They reported a fall in red cell count, packed cell volume and haemoglobin concentration in exposed workers although only the fall in the red cell count attained significance. Although they reported an insignificant rise in white cell counts in the exposed workers, differential counts revealed an increase in lymphocyte count and a decrease in monocyte count both of which were significant. In the present study, the haemoglobin concentration and PCV were significantly lower in the exposed subjects. The total white cell count increased significantly while the rise in granulocyte and agranulocyte counts remained insignificant. The major difference is that whilst Jude et al. (2002) reported a significant fall in platelet counts in the exposed group compared to the unexposed, the present study reports a significantly higher platelet count in the former. It is not clear why this is so. This disparity may be due to racial factors or variation in duration of exposure to cement dust. Their study population was Indian and had been exposed to cement dust for a period ranging from less than ten years to greater than twenty years. In the present study the population is Negroid and they had been exposed for 9.6 ± 1.5 years. However these differences suggest the need for more work to be done.

There was a general depression in the liver function parameters of cement factory workers compared with those of the control subjects. However, only the aspartate aminotransferase and alkaline phosphatase concentrations were significantly lower. These parameters, in either group, all fall within the normal reference range (Pagana and Pagana, 2005). The results suggest that the liver may not be adversely affected by cement dust exposure. A rise in the liver enzymes generally suggests a lesion in the liver (Pagana and Pagana, 2005). The results of the present study suggest that chronic exposure to cement dust has deleterious effect on the haemopoetic system while sparing the liver. Thus cement dust exposure may be more toxic than presently supposed. This notion is further strengthened by the reported genotoxic effects seen in people occupationally exposed to cement dust (Jude *et al*, 2002). Such genetic damage comprised of minor chromosomal aberrations, decrease in mitotic index and increased frequency of sister chromatid exchanges (Jude *et al*, 2002).

It is known that the components of cement dust show irritating, sensitizing and pneumoconiotic

properties (Maviejewska and Bielichowska-Cybula, 1991). Animal studies reveal that cement dust induces atrophic and hypertrophic changes in the nasal and pharyngeal mucosa as well as chronic exfoliative bronchitis (Maviejewska and Bielichowska-Cybula, 1991). Post mortem examination of the lungs of experimental animals exposed to cement dust revealed slight tissue fibrosis and some emphysema foci (Maviejewska and Bielichowska-Cybula, 1991). It is possible that these effects of cement dust observed in the lungs may also occur in the haemopoietic system. In addition, occupational exposure to silica, the major component of cement, may increase the risk of autoimmune disease. Carlsten *et al*, (2007) recently showed that cement masons had higher levels of proinflammatory cytokines and lower percentages of CD25+ and CD69+ lymphocytes compared to control. This led them to suggest that cement masons may be at a greater risk of a systemic proinflammatory state which could be linked to immune dysregulation (Carlsten *et al*, 2007). It is conceivable that such a proinflammatory state and the accompanying autoimmune disease process may occur in the haemopoietic system thereby accounting for the results of the present study.

All the workers who volunteered for this study were interviewed and they claimed to have complied with all the preventive measures taken by the cement factory. The results of this study suggest that either compliance to preventive measures was poor or the preventive measures were not effective. To safeguard the health of their workers and their host community, it is suggested, that the cement factory management embark on health education, acquire more effective protective gadgets and enforce their usage. There should also be containment or restriction of dust emission by the use of dust filters and this should be monitored with dust particles monitoring devices.

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References

Alakija, W., Iyawe, V.I., Jarikre, L.N., Chiwuzie, J.C. (1990). Ventilatory function of workers at Okpella cement factory in Nigeria. *West Afr J Med* 9(3): 187-192.

Al-Neaimi, Y.I., Gomes, J., Lloyd, O.L. (2001). Respiratory illnesses and ventilatory function among workers at a cement factory in a rapidly developing country. *Occup. Med*. 51 (6):367-373.

Azah, N., Antai, A.B., Peters, E.J., Osim, E.E. (2002). Effect of exposure to dust generated from crushing of granite rocks on the lung function of south eastern Nigerian children. *Niger. J. Physiol. Sci*. 17 (1-2): 42-47.

Jude, C.A.L., Sasikala, K., Ashok Kumar, R., Sudha, S., Raichel, J. (2002). Haematological and cytogenetic studies in workers occupationally exposed to cement dust. *Int. J. Hum. Genet*. 2(2): 95-99.

Carlsten, C., de Roos, A.J., Kaufman, J.D., Checkoway, H., Wener, M., Seixas, N. (2007). Cell markers, cytokines and immune parameters in cement mason apprentices. *Arthritis Rheum*. 57(1): 147-153.

Ezenwa, A.O. (1996). A study of the prevalence of occupational diseases and the factors affecting their identification and reporting in Nigeria. *Nig. Med. J*. 31:12-14.

Kanta, J., Horsky, J., Kovarova, H., Tilser, I., Korolenko, T.A., Bartos, F. (1986). Formation of granulomas in liver of silica treated rats. *Br. J. Exp. Pathol*. 67 (6):889-899.

Laraqui, C.H., Laraqui, O., Rahhali, A., Harourate, K., Tripodi, D., Mounassif, M., Yazidi, A.A. (2001). Prevalence of respiratory problems in workers at two manufacturing centers of ready-made concrete in Morocco. *Int. J. Tuberc. Lung Dis*. 5(11):1051-1058.

Maviejewska, A., Bielichowska-Cybula, G. (1991). Biological effect of cement dust. *Med. Pr*. 42(4): 281-289.

Meo, S.A., Azeem, M.A., Ghori, M.G., Subhan, M.M. (2002). Lung function and surface electromyography of intercostal muscles in cement mill workers. *Int. J. Occup. Med. Environ. Health* 15(3): 279-287.

Mwaiselage, J., Bratveit, M., Moen, B., Yost, M. (2005). Variability in dust exposure in a cement factory in Tanzania. *Ann. Occup. Hyg*. 49(6):511-519.

Noor, H., Yap, C.L., Zolkepli, O., Faridah, M. (2000). Effect of exposure to dust on lung function of cement factory workers. *Med. J. Malaysia* 55(2): 51-57.

Pagana, K.D., Pagana, T.J. (2005). *Mosby's Manual of Diagnostic and Laboratory Tests*. Mosby, St. Louis, Missouri, p 1095.

Pond, W.G., Yen, J.T., Hill, D.A., Ferrell, C.L., Krook, L. (1982). Bone lesions in growing swine fed 3% cement kiln dust as a source of calcium. *J. Anim. Sci*. 54(1):82-88.