Hematological and Biochemical Studies on Individuals Living Near Cement Industry

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Abstract: The manufacturing of cement is a dirty business. It involves a series of complicated steps that take raw stone from quarries and transform it into a very fine powder that attains remarkable qualities when mixed with water and air. Forty individuals lived near to cement industry have been investigated. They were divided into 4 groups according to their blood groups. Other forty individuals were used as a control category that's live in the city. Hematological parameters (Hemoglobin, hematocrit, red blood cells and whit blood cells) and biochemical constituents (Total protein, total bilirubin, urea, total lipid and cholesterol) were recorded in exposed and control categories. Also serum enzymes: serum alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (Alk ph), acid phosphatase (ACP), lactate dehydrogenase (LDH) and acetylcholine esterase (AchE) were estimated in both categories. On Other hands serum cations (Mg^{2+}, Fe^{3+} and Ca^{2+}) were measured in both categories. The Results showed that the level of hemoglobin, total protein, Mg2+, Fe3+ and Ca2+were significantly decreased while the urea level, ALT, AST,Alk ph, ACp,LDH, and AchE activities were markedly increased. The levels of total bilirubin, total lipid and cholesterol were almost the same in exposed and control subjects. In conclusion the individuals lived near cement industry are exposed to more oxidative stress compared to control subjects. This study to environment was undertaken to draw together scientific findings on cement industry and its releases and their impacts on human health. A broad range of health effects have been associated with living near to cement industry plants as well as working at these installations. The use of such biomarkers may sufficient to reflect the degree of relative susceptibility due to blood groups variation and also as good tools to indetect occupational exposure to pollutants in industrial plants.

Keywords: Hemoglobin, hematocrit, RBCs, WBCs, protein, bilirubin, lipid and cholesterol, ALT and AST, cement.

INTRODUCTION

Without cement, the primary ingredient in concrete, modern architecture and transportation could not exist. But the manufacture of cement produces a host of pollutants. Most cement plants burn coal for fuel, releasing toxins and particulate pollutants into the atmosphere. In addition, the heavy industrial machinery needed to create cement requires vast amounts of oil for lubrication. Then there's the ever-present dust byproducts–rock dust, clinker dust, cement kiln dust and powdered cement. Making cement is a dirty business. It involves a series of complicated steps that take raw stone from quarries and transform it into a very fine powder that attains remarkable qualities when mixed with water (Pamela White 2009). The cement industry provides direct employment for an estimated 850,000 workers worldwide (ERM, 2002). In 2001 global cement production was approximately 1.65 billion tones (USGS, 2002) estimated two thirds of global production was located in the top 10 producing countries. A study in U.S.A. showed that individuals living near to cement kilns burning hazardous waste. Significant increase in respiratory symptoms including lung disease, wheezing, persistent cough and bronchitis. The impact of cement kiln dust pollution on the environment was evaluated using the concentrations of heavy metals in the test and control sites as a guide. The manufacture of Portland and other cements has long been a primary part of the manufacturing sector in both developed and developing nation states. (Schwartz *et al.,* 1998) ciear that in Nigeria, the manufacture of cement and the use of cement in construction have been an integral part of the construction industry. To maintain quality control for cement products, the raw materials are pulverized to very fine discrete particle sizes and thoroughly mixed in controlled chemical proportions. The fuel burning to achieve the high temperatures combined with the fine particles of the raw materials results in the potential release of particulate matter which is defined as kiln dust. These dusts have been found a rich source of heavy metals and organics. The dust is emitted into the environment which now brings about considerable changes to the environment. The occurrence of occupational diseases is a very important indicator of the quality of working conditions and working environment. Respiratory diseases are extremely important in that the lung is both a route of entry and a target organ for noxious occupational agents. These agents can become aerosolized or airborne in the form of fibers, fumes, mists, or dusts. The Food and Agricultural Organization/World Health Organization (FAO/WHO) expert Committee on Food Additives established tolerable limits of Cd and Pb (FAO/WHO, 1972). In Egypt 2004 the number of the cement's companies has reached 14 companies and their production capacities has reached more than 35 million tons of normal grey cement and 700 thousand tons of white cement and within the next few years Egypt will become one of the top five global exporters of cement. Egypt's production capacity has increased by almost 21% since 2001, reaching 36.2 million tons in 2004. The study aims to clear the adverse effects of air pollution which release from industry specific cement industry on population lived near working place. The study was carried on individuals living near to Suez cement plant (~4Km).

MATERIAL AND METHODS

The eighty male selected individuals living near to cement industry plants were initially examined by a physician to make sure that they are free of parasites, hepatitis, bilharziasis and respiratory problems which would affect the whole blood picture and tested parameters.

Personal Informations:

The selected individuals were divided in to two categories: first category consists of forty male lived near Suez cement industry (Cabinon) and exposed to its dust since seven years. Such group were selected on the basis of oral questionnaire (age, sex, weight, blood group and behavior). The second one consists of forty male have been taken as a control who didn't live near any industry place. Each category divided in to four groups (ten individual in each group) according to its blood group.

Sampling:

10ml of venous blood collected from each individual under investigation for determination of selected hematological parameters with sterile syringes in tubes coated with sodium citrate. Serum and plasma were separated and stored at (-20°C) for hematological and biochemical studies.

Determination of hematological parameters:

Hemoglobin content (Hb) was determined by using spectrophotometic method. The commercial reagents of Diamond Diagnostics Egypt Company were used. Hematocrit values (Hct) were determined by centrifugation. The total count of red blood cells (RBCs) and white blood cells (WBCs) were determined using the hemocytometer slide (Lea and Febiger, 1964). The absolute values; mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentrations (MCHC) were also measured (Dacie *et al.,* 1991).

Determination of biochemical constituents:

Total protein, total bilirubin, blood urea, total lipid and cholesterol were estimated by spectrophotometic method using commercial reagents of Spinreact Spain Company (Young, 2001).

Determination of biochemical enzymes:

Acetylcholine esterase (AchE), alkaline phosphatase (Alk. ph), Acid phosphatase (Ac. ph) and lactate dehydrogenase (LDH) were assayed in plasma by colometric method using commercial reagents of Spain Spinreact. Serum Asparatate aminotransferase (AST) and alanine aminotransferase (ALT) were measured by randox reagent of United Kingdom (Schmidt *et al.,* 1963). All parameters recorded using a spectrophotometer RS232uv2000.

Determination of serum ions:

Serum magnesium (Mg^{2+}), iron (Fe^{3+}) and calcium (Ca^{2+}) were measured by reagents of Biocon Diagnostic Germany Company (Guder *et al.,* 1996).

Statistical analysis:

The results were expressed in mean±SE.Different groups were compared by ANOVA and significance level was $p<0.05$.

RESULTS

The blood picture of the exposed group and non exposed group is summaries in Table 2.

Hematological Parameters:

The data HB content, hematocrit and red blood cells decreased significantly in exposed compared with control individuals. The blood group (O) and (A) were more affected than (AB) and (B) group in exposed individuals. On other hand there were no significant difference in MCV, MCH and MCHC.

Biochemical constituent parameters:

Table (2) illustrated that Serum total proteins significantly decreased in exposed category compared with control group. Also blood group (O) and (A) were more affected than (AB) and (B) group in exposed individuals. But the blood urea increased significantly in exposed category compared with control Category. Also Serum total bilirubin, total lipid and cholesterol showed no significant difference between control and exposed individuals.

Enzymatic Parameters:

Table (3) showed significant increase of serum alanine aminotransferase, aspartat aminotransferase, alkaline phosphatase, acid phosphatase, Lactate dehydrogenase,and Plasma acetyl cholinesterase in exposed compared with control category, especially in blood group (O) and (A) than other groups.

Table 3 recorded that the levels of serum Calcium, Magnesium and Iron are significantly decrease in exposed category compared with control one, especially in blood group (O) and (A) than others groups.

Table (1): Non exposed and exposed workers information:

	Blood group	Age	Sex	Respiratory rate	Blood pressure
Exposed Category	**A**	(22-35)	male	(21- 22)	110/70
	B	(25-37)	male	(21 – 23)	120/80
	AB	(23-39)	male	(21- 22)	120/80
	O	(20-35)	male	(21- 22)	110/80
Control Category	**A**	(20-30)	male	(15 – 17)	120/70
	B	(23-36)	male	(15 – 16)	110/70
	AB	(30-40)	male	(14 – 16)	120/80
	O	(24-38)	male	(15 – 17)	120/80

Table (2): Comparative activity values of complete blood picture in control and exposed categories.

Hematology parameters	Blood group	Control means±SE (n=10)	Exposed means±SE (n=10)
Hemoglobin content (Hb) (g/dl)	A	16.6±0.40825[a]	14.0±0.40825[b]
	B	14.1±0.40825[a]	12.1±0.40825[b]
	AB	15.2±0.40825[a]	13.2±0.40825[b]
	O	17.6±0.40825[a]	15.0±0.40825[b]
Hematocrit(Hct) (%)	A	50.1±0.70[a]	42.0±0.60[b]
	B	42.3±0.70[a]	36.3±0.60[b]
	AB	45.6±0.70[a]	39.6±0.60[b]
	O	52.8±0.70[a]	45.6±0.60[b]
Red blood cells(RBCs) (106/ul)	A	5.6±0.063[a]	4.6±0.103[b]
	B	4.7±0.063[a]	4.0±0.103[b]
	AB	5.1±0.063[a]	4.4±0.103[b]
	O	5.9±0.063[a]	5.1±0.103[b]
White blood cells(WBCs) (103/ul)	A	5.35±0.14[a]	4.54±0.23[b]
	B	6.10±0.14[a]	5.29±0.23[b]
	AB	5.81±0.14[a]	4.95±0.23[b]
	O	4.80±0.14[a]	4.00±0.23[b]
MCV(fl)	A	89.4±1.98[a]	91.3±2.36[a]
	B	90.0±1.98[a]	90.7±2.36[a]
	AB	89.4±1.98[a]	90.0±2.36[a]
	O	89.4±1.98[a]	89.4±2.36[a]
MCH(pg)	A	29.6±0.46[a]	30.4±0.40[a]
	B	30.0±0.46[a]	30.2±0.40[a]
	AB	29.8±0.46[a]	30.0±0.40[a]
	O	29.8±0.46[a]	29.4±0.40[a]
MCHC(g/dl)	A	33.1±0.41[a]	33.3±1.35[a]
	B	33.3±0.41[a]	33.3±1.35[a]
	AB	33.3±0.41[a]	33.3±1.35[a]
	O	33.3±0.41[a]	33.3±1.35[a]

Means having the same letter are considered non –significantly different $p<0.05$.
n= the number of subjects (n=10).

Table (3): Comparative activity values of (Total protein- Serum total bilirubin- Blood urea- Serum total lipid- Serum cholesterol in control and exposed categories:

Biochemical constituent parameters	Blood group	Control means±SE (n=10)	Exposed means±SE (n=10)
Serum total protein (g/dl)	A	7.8±0.07272[a]	6.77±0.07272[b]
	B	6.4±0.08165[a]	5.37±0.08165[b]
	AB	7.2±0.08165[a]	6.17±0.08165[b]
	O	8.6±0.08360[a]	7.57±0.08360[b]
Serum total bilirubin (mg/dl)	A	0.84±0.04082[a]	0.83±0.04082[a]
	B	0.70±0.04082[a]	0.70±0.04082[a]
	AB	0.78±0.04082[a]	0.78±0.04082[a]
	O	0.86±0.04082[a]	0.84±0.04082[a]
Blood urea (mg/dl)	A	28.3±1.63299[a]	35.5±1.63299[b]
	B	22.1±1.63299[a]	28.8±1.63299[b]
	AB	24.5±1.63299[a]	31.2±1.63299[b]
	O	33.0±1.63299[a]	40.2±1.63299[b]
Serum total lipid (mg/dl)	A	700±4.08248[a]	700±4.08248[a]
	B	570±4.08248[a]	565±4.08248[a]
	AB	583±4.08248[a]	580±4.08248[a]
	O	800±4.08248[a]	810±4.08248[a]
Serum cholesterol (mg/dl)	A	200.1±2.44949[a]	200.6±2.44949[a]
	B	173.1±2.44949[a]	171.2±2.44949[a]
	AB	186.1±2.44949[a]	180.3±2.44949[a]
	O	210.5±2.44949[a]	210.7±2.44949[a]

Means having the same letter are considered non –significantly different $p<0.05$.
n: the number of subjects (n=10).

Table (4): Comparative activity values of (ALT – AST - Serum Alkaline phosphatase - Serum Acid phosphatase - LDH - Plasma acetylcholine esterase in control and exposed categories:

Enzymatic Parameters	Blood group	Control means±SE (n=10)	Exposed means±SE (n=10)	Change %
Serum ALT (U/l)	A	12.0±0.40825[a]	17.6±0.40825[b]	46.7
	B	8.0±0.40825[a]	13±0.40825[b]	62.5
	AB	10.0±0.40825[a]	15.2±0.40825[b]	52.0
	O	13.0±0.40825[a]	18.5±0.40825[b]	42.3
Serum AST (U/l)	A	0.51208[a]±12.0	0.51208[b]±17.0	41.7
	B	8.0±0.40825[a]	13.0±0.40825[b]	62.5
	AB	10.0±0.40825[a]	12.3±0.40825[b]	23.0
	O	14.0±0.40825[a]	19.4±0.40825[b]	38.6
Serum Alkaline phosphatase (U/l)	A	33±0.81650[a]	43±0.81650[b]	30.0
	B	20±0.81650[a]	29±0.81650[b]	45.0
	AB	30±0.81650[a]	38±0.81650[b]	26.7
	O	34±0.81650[a]	45±0.81650[b]	29.4
Serum Acid phosphatase (U/l)	A	3.4±0.04082[a]	6.0±0.04082[a]	76.4
	B	2.0±0.04082[a]	4.0±0.04082[a]	100
	AB	2.6±0.04082[a]	4.8±0.04082[a]	84.6
	O	4.0±0.04082[a]	7.2±0.04082[a]	80.0
Serum LDH (U/l)	A	230±4.08248[a]	330±4.08248[b]	43.4
	B	220±4.08248[a]	270±4.08248[b]	22.7
	AB	225±4.08248[a]	277±4.08248[b]	23.1
	O	239±4.08248[a]	355±4.08248[b]	48.5
Plasma acetylcholine esterase (U/l)	A	4200±8.16997[a]	5200±8.16997[b]	23.8
	B	3700±8.16997[a]	4200±8.16997[b]	13.5
	AB	3869±9.16515[a]	4569±9.16515[b]	18.0
	O	4278±8.16997[a]	5303±8.16997[b]	23.9

Means having the same letter are considered non –significantly different $p<0.05$.
n=the number of subjects (**n=10**).

Table (5): Comparative values of Serum Ca^{2+},Mg^{2+} and Fe^{2+} in control and exposed categories.

Biochemical constituent parameters	Blood group	Control means±SE (n=10)	Exposed means±SE (n=10)	Change %
Serum Calcium (mg/dl)	A	8.8±0.08165[a]	6.8±0.08165[b]	22.7
	B	7.9±0.08165[a]	6.2±0.08165[b]	21.5
	AB	8.2±0.08165[a]	6.4±0.08165[b]	21.9
	O	9.7±0.08165[a]	7.4±0.08165[b]	23.7
Serum magnesium (mg/dl)	A	2.15±0.08165[a]	1.75±0.08165[b]	18.6
	B	1.71±0.04082[a]	1.41±0.04082[b]	17.5
	AB	1.93±0.04082[a]	1.58±0.04082[b]	18.1
	O	2.55±0.04082[a]	2.10±0.04082[b]	17.6
Serum iron (mg/dl)	A	85.6±1.63299[a]	74.6±1.63299[b]	12.8
	B	72.1±1.37275[a]	62.1±1.37275[b]	13.8
	AB	78.4±1.63299[a]	67.7±1.63299[b]	13.6
	O	90.8±1.64126[a]	79.0±1.64126[b]	12.9

Means having the same letter are considered non –significantly different $P \leq 0.05$.
n: the number of subjects (**n=10**).

DISCUSSION

Respiratory rate:

In this study the respiratory rate was markedly increased in exposed individuals compared with control individuals. The route of entry of cement dust in the body is respiratory tract and / or through the gastrointestinal tract by inhalation or swallowing respectively. Both routes of entry are exposed to numerous potentially harmful substances in the cement mill environment (Green, 1970). By throwing more light industrial, technologic, scientific, political and social developments led to interventions that shaped contemporary responses to occupational and environmental disease (Corn,1996). Changes on the trachea influence the character and extent of changes in lungs and also its function which simply represented by respiratory rate of the individuals in that study. (Foltinova *et al.*, 2002). These results were in agreement with recent evidence indicates that occupational exposure to cement dust has produced deficits in respiratory function, the current evidence can not establish the dose-response relationship for these effects (Liezel Tipper; 2006).

Blood pressure

Pollution in the cement factory may not influence blood pressure directly, but inactivity and the psychological stress associated with working in a potentially hazardous environment are factors to consider. (Iyawe *et al.,* 2000).

Hematological parameters

In this study, the hematological parameters like Hb content, hematocrit, red blood cells and white blood cells were significantly decreased in exposed individuals as compared to control individuals while MCV, MCH. MCHC showed no difference between exposed individuals and control individuals. These results are consistent with the results which showed that the level of total red blood cells count (12%) and Hb (11%) were markedly decreased in exposed individuals as compared to control individuals. As cement workers are exposed to more oxidative stress compared to control subjects (Suleyman Aydin *et al.,* 2003). The results were in agreement with the results obtained which reported a significant decrease in the total number of red blood cells in packing cement workers in comparison with the control during winter season. A significant decrease in the hemoglobin concentration (Hb) and packed cell volume (PCV) (in kilns workers in comparison with the control during summer season. (zaid makki, 1999). Also in another study significant decreases of red blood cells (RBC), white blood cells (WBC), and neutrophils were observed and correlated with both personal benzene exposures and levels of urinary metabolites (S-phenylmercapuric acid and *t,t*-muconic acid) and albumin adducts of benzene oxide and 1,4-benzeoquinone(Qingshan Qu *et al.,* 2008).

Chemical constituent:

The study showed that serum total bilirubin, total lipid and cholesterol had no significant difference between both exposed and control individuals. Blood urea, AST, ALT, ALKph, Acph, LDH and AchE showed significant increase in exposed individuals compared with control individual. Also total protein recorded significant decrease in exposed individuals compared with control individual. In the same time all types of blood groups still having significant variation between each other in exposed groups and unexposed groups. All these treatments were in agreement with the results reported where the levels of ALT and AST were significantly increased to (61%) and (39%) of an exposed individuals respectively but levels of urea, protein, and cholesterol were almost the same in cement plant workers versus the control subjects. These results elucidating that cement workers are exposed to more oxidative stress than unexposed subjects (Suleyman Aydin *et al.,* 2003). Also in another study dealing with volunteer cement workers, serum transaminases were markedly increased over the reference values. (Tobias, 2001). A similar trend was noticed when male rabbits were treated with dimethoate, where serum total bilirubin, creatinine, S.G.P.T., ALkph and LDH increased but total protein and acetylcholine significantly decreased in treated groups (Abd El-shafi *et al.,* 2009).Also the activity of acid phosphatase increased with increasing intensity of pathological changes (Struzak *et al.,* 1990). But The activities of glutathione S-transferase, alkaline phosphatase, aspartate aminotransferase, alanine aminotransferase and acetyl cholinesterase were significantly decreased whereas, the activities of AST and ALT were increased in plasma. Treatment with $CdCl_2$ caused a significant increase in glucose, urea, creatinine and bilirubin in plasma. On the other hand, results showed that $CdCl_2$ significantly decreased plasma total protein, albumin, blood hemoglobin, total erythrocytic count and packed cell volume, while total leukocyte count increased (El-demerdash *et al.,* 2004).

Impacts on blood grouping

The results recorded that Blood group (O) and blood group (A) were more affected than blood group (AB) and blood group (B) in exposed individuals in hematological parameter (Hb content, hematocrit, red blood cells and white blood cells) also in biochemical constituents (Blood urea, AST, ALT, ALKph, Acph, LDH and AchE).In the same way in serum cations (calcium, magnesium and iron),in all countries of the world the human beings are remarkably polymorphic for the ABO blood type system. The populations are distributed in a high percent for type (O)and (A)representing about >80%of all populations and the rest 20% are in B and AB blood types (Lewontin,1982), thus variation in blood group type will be responsible for inter individual variation in response to Agro chemical exposure (El sebae *et al.,* 1996). Preston (1996) explained genetic susceptibility in relation to cancer. Shields (1994) demonstrated the pharmacogenetics in detecting sensitive populations. Thompson (1975) reported that there is an association between the ABO groups and susceptibility to certain diseases.Murant and Sobezak (1978) concluded that there was more data on disease relationships with blood groups specially of the ABO system than with any of the other systems. Also the variation in both biochemical and toxicological responses of different blood groups due to exposure to pesticides was initially studied by El sebae(1984), Enan *et al.* (1985)and more recently by El sabae at 2002.

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دراسات الهيماتولوجية والبيوكيميائية على الأفراد المقيمين بالقرب من مصانع الأسمنت

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*قسم حماية البيئة -كلية العلوم الزراعية بالعريش-جامعة قناة السويس-مصر

**كلية الصيدلية جامعة الإسكندرية - مصر

صناعة الاسمنت من الأعمال القذرة.حيث انه ينطوي على سلسلة من الخطوات المعقدة التي تتخذ من مقالع الحجر الخام وتحويله إلى مسحوق ناعم جدا إلى إن ينال الصفات المطلوبة عندما يخلط مع الماء والهواء.أجريت هذه الدراسة بمنطقة كابينون (بجوار مصنع اسمنت السويس).تم اختيار ٨٠فرد تتراوح أعمارهم ما بين٢٠الى ٤٠ عام وقسمت الأفراد إلى مجموعتين بواقع ٤٠فرد معرضين لأتربة مصنع الاسمنت حيث أنهم يعيشون على بعد أربعه كيلومترواستخدمت المجموعة الأخرى كمجموعة ضابطة.لوحظ انخفاض مستوى الهيموجلوبين ونسبة البروتين الكلى ونسبة الماغنسيوم والحديد والكالسيوم بالدم لإفراد المجموعة الأولى (المعرضة)بينما بطريقة ملحوظة. سجلت النتائج ارتفاع مستوى اليوريا ونشاط الأنزيمات آلاتية (AST,ALT,Alkph (AC p,LDH and AchE وهناك مدى واسع من الآثار الصحية تتصاحب مع الذين يعيشون قرب مصانع الاسمنت وكذلك العاملين في هذه المنشآت. واستخدام هذه الأدلة الحيوية قد تكفي لعكس درجة قابلية فئات الدم للتأثر وأيضا باعتبارها أدوات جيدة للكشف عن التعرض للملوثات في المنشآت الصناعية.