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ORIGINAL ARTICLE

Cardiovascular Disease Risk Factors and Cardiac Markers among Male Cement Workers in Calabar, Nigeria

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KEYWORDS

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ABSTRACT: Prolonged or repeated exposure to cement dust, depending on the duration, level of exposure and individual sensitivity has health implications on the skin, eyes, respiratory and haematological systems. This study assessed cardiovascular disease risk factors and cardiac markers among cement workers of Nigerian origin to determine the effects of duration of exposure to cement dust on these parameters. Troponin I, Creatine kinase MB (CK-MB), anthropometric indices, lipid profile, fasting plasma glucose (FPG) and atherogenic index of plasma (AIP) were determined in 50 cement workers and 40 controls. The cement workers were sub-grouped based on their duration of exposure. Significance level for statistical analyses was set at $P < 0.05$. The mean total cholesterol ($P < 0.0001$), HDL-cholesterol ($P = 0.030$), LDL-cholesterol ($P = 0.004$), VLDL-cholesterol ($P < 0.0001$), Triglycerides ($P < 0.0001$), troponin ($P < 0.0001$), CK-MB ($P = 0.001$) and AIP ($P = 0.004$) values were significantly higher in cement workers when compared with controls. There were no significant differences ($P>0.05$) in FPG levels and the anthropometric indices measured. Cement workers with duration of exposure > 8years had higher mean values of FPG, CK-MB, total cholesterol, LDL-cholesterol. This study has shown that lipid profile, troponin and CK-MB levels are significantly higher in cement workers compared to controls. Cement workers may be at a greater risk of developing cardiovascular disease.

INTRODUCTION

Cement is an important key to economic growth because of its role in construction, housing and infrastructural development [1]. Its demand is directly associated with economic growth and the need for rapid infrastructural development in many growing economies is the main motivation for the tremendous growth in cement manufacture and use [1]. In spite of its popularity and profitability, the

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cement industry faces many challenges due to sustainability issues and environmental concerns [2].

The majority of cardiovascular disease (CVD) is caused by risk factors that can be controlled, treated or modified. Cardiovascular risk is outcome of the contributions of the effects of many risk factors. The clustering together of individual factors in a significant pattern tends to increase an individual's total cardiovascular risk [3]. These cardiovascular risk factors include high blood pressure, abnormal blood lipid, diabetes, overweight and obesity, smoking, alcohol intake, physical inactivity. Other cardiovascular risk factors are non-modifiable and include age, gender and family history [3].

The level of cholesterol in blood is related to the development of atherosclerosis and myocardial infarction. Abnormality of cholesterol metabolism and may lead to cardiovascular accidents and heart attacks [4]. Atherogenic index of plasma (AIP) has been shown to indicate the true relationship between atherogenic and protective lipoproteins. It is therefore very effective in predicting the risk of atherosclerosis as well as coronary heart disease [5]. An AIP value of under 0.11 is associated with low risk of cardiovascular disease, the values between 0.11 to 0.21 and greater than 0.21 are associated with intermediate and high risks, respectively [6]. The Castelli or the atherogenic index (total cholesterol:high-density cholesterol lipoprotein ratio) is also a very strong indicator of cardiovascular risk [7].

High blood pressure is a condition in which blood pressure in the arteries is persistently elevated i.e. systolic blood pressure (SBP) of 140 mmHg or more or a diastolic blood pressure (DBP) of 90mmHg or more [8]. Long-term high blood pressure may result in damage to the heart. Troponin is an important marker of cardiac function. It is used to evaluate the integrity of the heart [9]. Among the many cardiac markers including creatine kinase and myoglobin it is the most specific and sensitive and is used most because of this advantage [10]. Creatine kinase is an intracellular enzyme present in cells of the heart, brain and skeletal muscle. Disruption of cell membrane due to hypoxia release creatine kinase MB (CK-MB), an isoenzyme of creatine kinase from the cellular cytosol into the systemic circulation, on this basis elevated serum level of CK-MB have been used as a sensitive marker for myocardial infarction [11]

Workers associated with cement are exposed to dust at various stages of manufacturing which include production and post-production processes. Main entries of cement dust particle into the body are by inhalation or swallowing and as such, its target of deposition is the respiratory and gastro-intestinal tracts also affected are the skin and the eyes [12]. Hazardous materials in cement such as calcium oxides are corrosive to human tissue, crystalline silica is abrasive to the skin and damages the lungs and chromium causes allergic reactions [13] resulting in various health problems such as chronic cough, phlegm production, impairment of lung function, chest tightness, bronchial asthma restrictive lung disease, skin irritation, conjunctivitis, stomach ache, headache as well as cancer of the lungs [14]. 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 has health implications on the skin, eyes, respiratory and haematological systems [15-17]. There is a dearth however of information on the effect of exposure to cement dust on cardiovascular risk factors. Some studies have associated cement dust exposure with both increased oxidative stress and decreased anti-oxidant capacity, which in turn can promote lipid peroxidation [18] and consequently dyslipidaemia [19]. A modest association between exposure to cement and type 2 diabetes mellitus has also been suggested [20]. These conditions are associated with increased cardiovascular disease risk. The few available studies were carried out on Caucasian and Hispanic populations, hence the need for this study.

This study investigated troponin I, Creatine kinase MB (CK-MB), lipid profile, fasting plasma glucose (FPG) levels, anthropometric indices, atherogenic index of plasma and total cholesterol: HDL-cholesterol ratio Nigerian workers occupationally exposed to cement dust.

MATERIALS AND METHODS

Study design and subject selection

This is a case-control study. Ninety male subjects participated in the study. Fifty people occupationally exposed to cement dust were recruited as test subjects. Forty age-matched apparently healthy male subjects who were not occupationally exposed to cement dust were recruited as controls. Subjects were between the ages of 18 and 75 yr. The cement workers were grouped based on their duration of exposure to cement dust, the first group was composed of those with duration of exposure of up to 4 yr, the second group had duration of exposure 5 to 8 yr and the third more than 8 yr. Atherogenic Index Plasma was calculated according to the formula, log (TG/HDL-C) [6]. Subjects with AIP value of > 0.11 [6], CK-MB values >25IU/L (from the Giesse kit insert) and those who had Total cholesterol: HDL-cholesterol ratio >5 [21] were considered to have increased cardiovascular disease risk factors.

This study was carried out in accordance with the ethical requirements of the World Medical Association [22]. The purpose and nature of the research was explained to each participant and informed consent was obtained. A standard questionnaire was administered to them to obtain information from the subjects about their age, family history, dietary and physical lifestyle.

Sample collection

Blood samples were taken from each subject after an overnight fast. Five ml of blood was aseptically collected into plain bottles, left to clot and the serum extracted and stored frozen until used.

Measurement of anthropometric indices

Weight and height of each subject were measured. The measurement of weight in kilograms was done using a weighing balance and measurement of height (in metres) was done using a stadiometer. Waist circumference (in centimeters) was calculated by taking the average of two measurements taken, one after breathing in and the other taken after breathing out, at the midpoint between the top of the iliac crest and the bottom of the rib cage using an inelastic calibrated tape. Body mass index (BMI) was calculated by dividing the weight (kg) measured to the square of height (meters) of each participant. Waist-hip ratio was calculated as a ratio of waist and hip circumference.

Assay Methods

Determination of glucose, total and HDL-cholesterol and triglycerides was done using the enzymatic colorimetric methods with kits obtained from Fortress Diagnostics, United Kingdom. Friedewald’s equation was used to calculate both VLDL-cholesterol and LDL-cholesterol. Determination of serum troponin levels was carried out using an ELISA troponin I assay kit by Monobind Incorporation, Lake Forest, USA. Creatine kinase was measured using an immuno-inhibition kinetic kit obtained from Giesse Company in Guidonia Monticello, Italy. All the tests were carried out according to the instructions of the manufacturers.

STATISTICAL ANALYSIS

Statistical analysis was done using the PAW statistic 18, a statistical package from SPSS Inc, California, USA. The results were expressed as Mean ± SD. Student's *t*-test and analysis of variance (ANOVA) was used to analyze the data. Post-hoc analysis was done using least significant difference (LSD). Pearson's correlation was also performed. The level of significance was set at 95% confidence interval, where a probability value ($P<0.05$) was regarded as being statistically significant.

RESULTS

A comparison of plasma glucose, lipid profile, troponin, creatine kinase MB, anthropometric indices, blood pressures and atherogenic index of plasma in cement workers and controls showed that total cholesterol (P = 0.0001), HDL-cholesterol (P = 0.030), LDL-cholesterol (P = 0.004), VLDL-cholesterol (P = 0.0001), triglycerides (P = 0.0001), AIP (P = 0.004), total cholesterol: HDL-cholesterol ratio (P = 0.035) troponin (P = 0.0001) and creatine kinase MB (P = 0.001) were significantly higher in cement workers than in controls. There was however, no significant difference (P> 0.05) in the mean values of fasting plasma glucose (FPG), body mass index (BMI), waist circumference (WC), waist hip ratio (WHR), systolic and diastolic BP between the cement workers and the controls (Table 1).

Table 1. Comparison of plasma glucose, lipid profile, troponin, creatine kinase MB, anthropometric indices, blood pressures and atherogenic index of plasma in cement workers and controls

Parameter	Cement worker, sn=50	Controls, n=40	Calc t	Crit. *t*	*P*-value
Age (yr)	32.8 ± 11.39	30.9± 11.04	0.780	1.98	0.437
FPG (mmol/L)	5.73 ± 0.88	5.98 ± 0.79	1.408	1.98	0.163
Total cholesterol (mmol/L)	5.12 ± 2.10	3.71 ± 0.96	4.219	1.98	0.0001*
HDL-cholesterol (mmol/L)	1.50 ± 0.45	1.31 ± 0.31	2.203	1.98	0.030*
LDL-cholesterol (mmol/L)	2.87 ± 2.04	1.91 ± 0.93	2.962	1.98	0.004*
VLDL-cholesterol (mmol/L)	0.74 ± 0.30	0.48 ± 0.23	4.595	1.98	0.0001*
Triglycerides (mmol/L)	1.64 ± 0.66	1.07 ± 0.50	4.60	1.98	0.0001*
Troponin (ng/ml)	0.20 ± 0.14	0.08 ± 0.05	5.478	1.98	0.0001*
Creatine kinase MB (IU/L)	22.2 ± 11.34	16.1 ± 4.98	3.378	1.98	0.001*
BMI (kg/m^2)	25.0 ± 4.85	24.4± 4.04	0.633	1.98	0.528
Waist circumference (cm)	83.2 ±11.20	79.3 ± 10.10	1.704	1.98	0.092
Waist/Hip ratio	0.87 ±0.07	0.85 ±0.06	1.374	1.98	0.173
Systolic BP (mmHg)	127.4 ±14.37	130.6 ±15.66	1.007	1.98	0.317
Diastolic BP (mmHg)	82.4 ±17.91	82.6 ±12.53	0.094	1.98	0.925
Atherogenic Index of plasma	0.021 ±0.24	-0.13 ±0.25	2.961	1.98	0.004*
Total cholesterol:HDL-cholesterol ratio	3.65 ±1.75	2.99 ±1.17	2.145	1.98	0.035*
*** significant at *P*<0.05**					

Mean ± SD

A comparison of plasma glucose, lipid profile, troponin, creatine kinase MB, anthropometric indices, blood pressures and atherogenic index of plasma in cement workers with different durations of exposure to cement dust showed significant variations in FPG (P = 0.004), LDL-cholesterol (P = 0.046), Creatine kinase MB (P = 0.001), BMI (P = 0.001) and waist circumference (P = 0.001) among the groups. However no significant variations (P>0.05) were observed in the total cholesterol, HDL-cholesterol, VLDL-cholesterol, triglyceride, troponin, waist-hip ratio, systolic and diastolic BP and AIP values among the groups (Table 2).

Table 2. Comparison of plasma glucose, lipid profile, troponin, creatine kinase MB, anthropometric indices, blood pressures and atherogenic index of plasma in cement workers with different durations of exposure to cement dust

Parameter	≤ 4year, n=26	5 – 8 yr, n=10	>8years, n=14	Calc F	Crit. F	*P*-value
FPG (mmol/L)	5.42± 0.75	6.47 ± 0.70	5.77± 0.95	6.336	3.195	0.004*
Total cholesterol (mmol/L)	4.47± 1.65	5.50 ± 2.37	6.04 ± 2.39	2.930	3.195	0.063
HDL-cholesterol (mmol/L)	1.47 ± 0.41	1.56 ± 0.40	1.51± 0.56	0.162	3.195	0.851
LDL-cholesterol (mmol/L)	2.23 ± 1.48	3.17 ± 2.32	3.86 ± 2.44	3.280	3.195	0.046*
VLDL-cholesterol (mmol/L)	0.78±0.30	0.77 ± 0. 40	0.67 ± 0.22	0.598	3.195	0.554
Triglycerides (mmol/L)	1.71± 0. 67	1.70± 0.87	1.48± 0.47	0.598	3.195	0.554
Troponin (ng/ml)	0.24 ±0.17	0.15 ± 0.11	0.17 ± 0.08	1.868	3.195	0.166
Creatine kinase MB (IU/L)	17.01 ± 9.33	25.51 ± 9.49	29.63 ± 11.98	7.530	3.195	0.001*
BMI (kg/m^2)	22.86± 2.15	25.41± 4.40	28.67±6.53	8.629	3.195	0.001*
Waist circumference (cm)	77.96±4.87	86.90± 12.07	90.29±14.37	7.955	3.195	0.001*
Waist/Hip ratio	0.86 ±0.06	0.89±0.085	0.89±0.075	1.019	3.195	0.369
Systolic BP (mmHg)	125.4 ±15.27	130.9 ±16.55	128.5±11.02	0.574	3.195	0.567
Diastolic BP (mmHg)	80.9 ±22.62	82.1 ±12.01	85.4 ± 10.52	0.281	3.195	0.756
Atherogenic Index of plasma	0.04 ± 0.23	-0.002 ±0.28	-0.007±0.22	0.275	3.195	0.761
Total cholesterol:HDL-cholesterol ratio	3.12 ± 1.00	3.91 ±2.49	4.45±2.00	2.991	3.195	0.060

* significant at *P*<0.05   Mean ± SD

Post hoc analysis showed that the mean values of FPG, TC, LDL-cholesterol, BMI, waist circumference, creatine kinase MB and total cholesterol:HDL-cholesterol ratio were significantly higher in cement workers that had longer duration of exposure to cement dust (*P*<0.05) with the highest mean values observed in subjects that had duration of exposure of more than 8 years (Table 3).

Table 3. Comparison of fasting plasma glucose, waist circumference, creatine kinase MB, body mass index, total and LDL-cholesterol in cement workers with different durations of exposure to cement dust using post hoc analysis.

Parameter	Groups		Mean Difference	Std Error	*P*-value
	≤ 4year, n=26	**5 – 8 yr, n=10**			
FPG (mmol/L)	5.42 ± 0.75	6.47 ± 0.70	-1.055	0.297	0.001*
Waist circumference (cm)	77.96 ± 4.87	86.90 ± 12.07	-8.938	3.677	0.019*
Creatine kinase MB (IU/L)	17.01 ± 9.33	25.51 ± 9.49	-8.487	3.635	0.024*
	≤ 4year, n=26	**>8years, n=26**			
TC (mmol/L)	4.47± 1.65	6.04 ± 2.39	-1.563	0.672	0.024*
LDL-cholesterol (mmol/L)	2.23 ± 1.48	3.86 ± 2.44	-1.627	0.649	0.016*
BMI (kg/m^2)	22.86 ± 2.15	28.67 ± 6.53	-5.814	1.404	0.0001*
Waist circumference (cm)	77.96 ±4.87	90.29 ±14.37	-12.324	3.275	0.0001*
Creatine kinase MB (IU/L)	17.01 ± 9.33	29.63 ± 11.98	-12.620	3.433	0.001*
Total cholesterol:HDL-cholesterol ratio	3.12 ± 1.00	4.45 ± 2.00	-1.330	0.557	0.021*
	5 – 8 yr, n=10	**>8years, n=26**			
FPG (mmol/L)	6.47 ± 0.70	5.77± 0.95	0.699	0.330	0.040*

* significant at *P*<0.05

Table 4 shows the percentage of subjects with increased cardiovascular disease risk factors with respect to the atherogenic index of plasma (AIP), CK-MB and total cholesterol: HDL-cholesterol ratio. The percentage of cement workers with increased values of AIP and total cholesterol: HDL-cholesterol ratio was higher than the percentage of controls increased values of the aforementioned parameters though this was not statistically significant (*P* >0.05). The percentage of cement workers with increased CK-MB values was significantly higher than those of the controls were.

A significant positive correlation was observed between CK-MB and total cholesterol: HDL-cholesterol ratio (r = 0.344, *P* = 0.014) of cement workers (Figure 1).

Table 4. Percentage of subjects with increased cardiovascular disease risk factors

Cardiovascular risk factors	Cement workers(n=50), % (n)	Controls (n = 40), % (n)	*P*-value
Atherogenic index of plasma	32% (16)	17.5%(7)	0.056
CKMB	66% (36)	0% (0)	0.0001*
Total cholesterol: HDL-cholesterol ratio	14% (7)	7.5% (3)	0.065

* significant at *P*<0.05

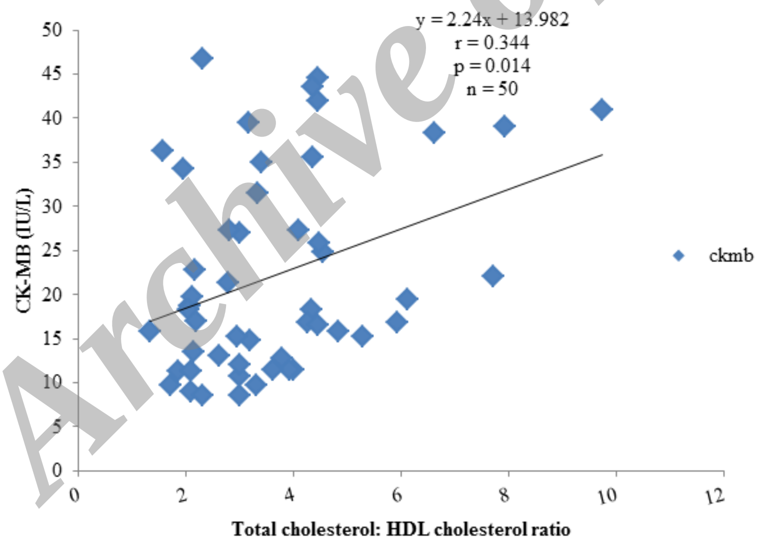

Figure 1. Correlation plot of creatine kinase MB against total cholesterol: HDL cholesterol ratio in cement workers.

DISCUSSION

Exposure to cement dust has been implicated as a likely causative agent in various health problems [14]. Cement dust exposure has also been associated with both increased oxidative stress and decreased anti-oxidant capacity, which in turn can promote lipid peroxidation [18] and consequently dyslipidaemia [19]. A modest association between exposure to cement and type 2 diabetes mellitus has also been suggested [20]. In this study, we evaluated some cardiovascular risk factors including the lipid profile, atherogenic index of plasma, total cholesterol: HDL-cholesterol ratio, anthropometric indices, fasting blood glucose and blood pressures as well as troponin I and myoglobin.

Higher levels of total cholesterol, LDL-cholesterol, VLDL-cholesterol and triglycerides were observed in the cement workers compared to the controls in this study. Cement dust contains a mixture of metals [23] and other toxic substances such as dioxins that interfere with lipid metabolism [20]. 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) which is a type of dioxin present in cement inhibits lipoprotein lipase [20] which results in decreased clearance of VLDL and chylomicrons resulting in increased levels of triglycerides. This may be responsible for the increased levels of triglycerides observed in the cement workers in this study. Cement dust from Nigeria contains higher concentrations of cadmium, lead and Hg compared to those from the USA [23]. Exposure to these heavy metals has been implicated in distinct pathological changes including dyslipidemia. Chronic exposure to both high and low dose cadmium concentrations adversely affect lipid and lipoprotein profile via lipid peroxidation and increase in the activity of hydroxy-3-methylglutaryl-coenzyme A (HMG CoA) reeducates, which is the rate-limiting enzyme in cholesterol synthesis [24-26]. Lead increases the activity of HMG CoA reductase and reduces the number/affinity of LDL receptors for cholesterol. Exposure to mercury causes lipid peroxidation [27]. These might account for the higher total and LDL-cholesterol values seen in the cement workers in this study. Our findings are consistent with those of other studies [19, 28 and 29] who reported increases in total cholesterol, LDL-cholesterol and triglycerides in cement workers elsewhere. The reason for the higher HDL-cholesterol in the cement workers is unclear but might be attributed to physically active lives of the cement workers arising from the demands of their occupations [30]. This observation is contrary to another study that reported lower HDL-cholesterol levels [19].

However, the gains from higher HDL-cholesterol levels are minimal as shown by both the higher mean AIP and total cholesterol: HDL cholesterol ratio of the cement workers. The cement workers with the highest duration of exposure were observed to have the highest mean values of total and LDL-cholesterol and total cholesterol: HDL-cholesterol ratio. This scenario depicts a dose-response relationship between the duration of exposure and the aforementioned parameters. Hyperlipidaemia constitutes a major etiopathological factor for atherosclerosis and cardiovascular diseases [31]. Environmental factors are being increasingly implicated in the pathogenesis of dyslipidemia. Elevated concentrations of total or LDL cholesterol in the blood are powerful risk factors for coronary disease. The unfavourable changes in the lipid profile as well as increased AIP and total cholesterol: HDL cholesterol ratio of the cement workers in this study is a pointer to an increased risk of cardiovascular disease in this group of people [32].

In this study, both the troponin and creatine kinase MB levels of cement workers were significantly higher than that of the controls. Cement is known to cause chronic respiratory distress or impairment resulting in heart being deprived of sufficient oxygen supply, which may lead to myocardial injury [33]. Cement dust causes increase in both cardiac markers by oxidative stress, decrease in cardiac output and hypotension [34-35]. Cadmium, a heavy metal found in cement causes oxidative stress-mediated cardiotoxicity shown by a significant increase in both troponin and creatine kinase MB [36].Though the troponin levels of cement workers were higher than that of controls, all their values were within the normal range. A significantly higher percentage of cement workers

(66%) had higher than normal CK-MB. This shows the presence of minor injury to the heart and suggests that cement workers may be at a higher risk of developing myocardial injury in the near future. The positive correlation between CK-MB and total cholesterol: HDL-cholesterol ratio of the cement workers further strengthens the observation that increase in total cholesterol: HDL-cholesterol ratio is an important risk factor that causes minor myocardial damage, which may consequently result in myocardial damage. Similar findings were made in another study where a positive correlation between CK-MB and total cholesterol: HDL-cholesterol ratio was reported in patients with unstable angina [37].

The other cardiovascular risk factors measured in this study (anthropometric indices (waist circumference (WC), waist hip ratio (WHR), body mass index (BMI), fasting plasma glucose, and both diastolic and systolic pressure) did not show any statistically significant difference. between the control subjects and cement workers, thus suggesting that these factors may not play any significant role in the cardiovascular disease that may occur in this group of workers. Our findings are similar to those in other studies [33, 38]. This may be due to fact that the cement workers are involved in strenous jobs; as a result, the beneficial effects of their physical activities on the anthropometric indices, fasting plasma glucose and blood pressures may counteract any deleterious effect associated with the exposure to cement dust. However, another study reported higher blood glucose levels which is contrary to the findings of our study [19].

It was observed that the only cardiovascular risk factors that were significantly higher in the cement workers were the lipids as there was no significant difference in the anthropometric indices, fasting plasma glucose, and both diastolic and systolic pressure in both groups. The cardiac markers troponin and CK-MB were also significantly higher in cement workers.

CONCLUSIONS

Total cholesterol, triglycerides, LDL-cholesterol, VLDL-cholesterol, HDL-cholesterol, troponin and creatine kinase MB levels are significantly higher in cement workers compared to controls. This suggests that cement workers may be predisposed to cardiovascular disease.

CONFLICT OF INTEREST

All authors declare no conflict of interest.

REFERENCES

1. Potgieter J.H., 2012. An overview of cement production: How "green" and sustainable is the industry? EMSD. 1(7), 14 - 37.

2. Khana S., Chouhanb V., Chandrac B., Goswami S., 2014. Sustainable accounting reporting practices of Indian cement industry: An exploratory study. Uncertain Supply Chain Management. 2, 61–72.

3. Mendis S., Puska P., Norving B. Global atlas on cardiovascular disease prevention and control. World Health Organisation in collaboration with world heart federation and world stroke organization: Geneva, 2011.

4. Vasudevan D.M., Sreekumari S., Kannan V., Textbook of Biochemistry. 6th ed., Jaypee Brothers Medical Publishers Limited: New Delhi, 2011

5. Tariq M., Ali R., 2012. Comparative study for atherogenic index of plasma (AIP) in patient with type 1 diabetes mellitus, type 2 diabetes mellitus, Beta thalassemia and hypothyroidism. Int J Chem Res. 2,1-9.

6. Dobiasova M., Frohlich J., Sedova M., Cheung M.C., Brow, B.G., 2011. Cholesterol esterification and atherogenic index of plasma correlate with lipoprotein size and findings on coronary angiography. J Lipid Res. 52(3), 566-571.

7. Millán J., Pintó X., Muñoz A., Zúñiga M., Rubiés-Prat J., Pallardo L.F., Masana L., Mangas A., Hernández-Mijares A., González-Santos P.,

Ascaso J.F., Pedro-Botet J., 2009. Lipoprotein ratios: Physiological significance and clinical usefulness in cardiovascular prevention. Vasc Health Risk Manag. 5,757-765.

8. Roger V.L., Go A.S., Lloyd-Jones D.M., Benjamin E.J., Berry J.D., Borden W.B., Bravata D.M., Dai S., Ford E.S., Fox C.S., 2012. Heart disease and stroke statistics--2012 update: a report from the American Heart Association. Circulation. 125(1), e2-e220.

9. Bodor G.S., 2016. Biochemical markers of myocardial damage. eJIFCC. 27(2), 95-111

10. Christenson E., Christenson R.H., 2013. Characteristics of cardiac troponin. Coron Artery Dis. 24(8), 698-704.

11. Alpert J.S., Thygesen K., Antman E., Bassand J.P., 2000. Myocardial Infarction redefined – a consensus document of the joint European society of Cardiology/American College of Cardiology Committee for the redefinition of Myocardial Infarction. J Am Coll Cardiol. 36(3), 959-969.

12. Meo A.S., 2004. Dose responses of years of exposure on lung function in flour mill workers. J Occup Health. 46(3), 187–191.

13. Syed S., Bhat G.A., Henah M.B., 2013. Health risks associated with workers in cement factories. IJSRP. 3(5), 1–5.

14. Meo S.A., Rasheed S., Khan M.M., Shujauddin S., Al-Tuwaijri A.S., 2008. Effect of cement dust exposure on phagocytic function of polymorphonuclear neutrophils in cement mill workers. Int J Occup Med Environ Health. 21(2),133–139.

15. Zawilla N., Taha F., Ibrahim Y., 2014. Liver functions in silica-exposed workers in Egypt: possible role of matrix remodeling and immunological factors. Int J Occup Environ Health. 20(2), 146-156.

16. John O., Olubayo M., 2011. Biochemical and haematological profile in Nigerian cement factory workers. RJET. 5,133 – 140.

17. Mojiminiyi F.B., Merenu I.A., Ibrahim M.T., Njoku C.H., 2008. The effect of cement dust exposure on haematological and liver function parameters of cement factory workers in Sokoto, Nigeria. Niger J Physiol Sci. 23(1-2), 111-114.

18. Aydin S., Aral I., Kilic N., Bakan I., Aydin S., Erman F., 2004. The level of antioxidant enzymes, plasma vitamins C and E in cement plant workers. Clin Chim Acta. 341, 193-198.

19. Aydin S., Aydin S., Croteau G. A., Sahin I., Citil C., 2010. Ghrelin, nitrite and paraoxonase / arylesterase concentrations in cement plant workers. J Med Biochem. 29(2), 78 – 83.

20. Haro-García L., Juárez-Pérez C.A., Aguilar-Madrid G., Sánchez-Escalante V., Muñoz-Navarro S., Pérez-Lucio C., 2010. Type 2 diabetes in Mexican workers exponed to a potential source of dioxins in the cement industry determined by a job exposure matrix. Med Segur Trab. 56(219), 114-123.

21. Quispe R., Manalac R.J., Faridi K.F., Blaha M.J., Toth P.P., Kulkarni K.R., Nasir K., Virani S.S., Banach M., Blumenthal R.S., Martin S.S., Jones S.R., 2015. Relationship of the triglyceride to high-density lipoprotein cholesterol (TG/HDL-C) ratio to the remainder of the lipid profile: The Very Large Database of Lipids-4 (VLDL-4) study. Atherosclerosis. 242(1), 243-250.

22. World Medical Association's Declaration of Helsinki. Recommendations Guiding Physicians in Biomedical Research Involving Human Subjects. Adopted by the 18th World Medical Assembly, Helsinki; Finland, June, 1964, and amended by the 48th General Assembly, Somerset West, Republic of South Africa, October 1996.

23. Ogunbileje J.O., Sadagoparamanujam V.M., Anetor J.I., Farombi E.O., Akinosun O.M., Okorodudu A.O., 2013. Lead, mercury, cadmium, chromium, nickel, copper, zinc, calcium, iron, manganese and chromium (VI) levels in Nigeria and United States of America cement dust. Chemosphere. 90(11), 2743-2749.

24. Murugavel P., Pari L., 2007. Diallyl tetrasulfide protects cadmium-induced alterations

in lipids and plasma lipoproteins in rats. Nutr Res. 27, 356–361.

25. Olisekodiaka M.J., Igbeneghu C.A., Onuegbu A.J., Oduru R., Lawal A.O., 2012. Lipid, lipoproteins, total antioxidant status and organ changes in rats administered high doses of cadmium chloride. Med Princ Pract. 21, 156–159.

26. Samarghandian S., Azimi-Nezhad M., Shabestari M.M., Azad F. J., Farkhondeh T., Bafandeh F., 2015. Effect of chronic exposure to cadmium on serum lipid, lipoprotein and oxidative stress indices in male rats. Interdiscip Toxicol. 8(3), 151–154.

27. Kobal A.B., Horvat M., Prezelj M., Briski A.S., Krsnik M., Mazej T.D.D., Falnoga I., Stibilj V., Arneric N., Kobal D., Osredkar J., 2004. The impact of long term exposure to elemental mercury on antioxidative capacity and lipid peroxidation in mercury miners. J Trace Elem Med Biol. 17(4), 261 – 274.

28. Modhir N.A., Mohamed A.R., Rawaa J., 2014. Study of some Biochemical changes in the blood serum of Sadet-Al-Hindiah cement factory workers, Babylon, Iraq. Int J Interdiscip Multidiscip Stud. 2, 700 – 702.

29. Dier M.S., Sirwan M.M., Longman O.H., 2014. Some biochemical and Hematological parameters among petroleum and cement factory workers in Sulaimaniyah city/Kurdistan/ Iraq. Chem Material Res. 6(8), 29-33.

30. Ademuyiwa O., Ugbaja R.N., Idumebor F., Adebawo O., 2005. Plasma lipid profiles and risk of cardiovascular disease in occupational lead exposure in Abeokuta. Nigeria Lipids Health Dis. 4, 19.

31. Banerjee S.K., Maulik S.K., 2002. Effect of garlic on cardiovascular disorders: a review. J Nutr. 1(4), 1-14.

32. Bravo E., Napolitano M., Botham K., 2012. Post prandial lipid metabolism: The missing link between life-style habits and the increasing incidence of metabolic diseases in western countries. Open Transl Med J. 2, 1-13.

33. Meo S.A., Al-Drees A.M., Al Masri A.A., Al Rouq F., Azeem M.A., 2013. Effect of duration of exposure to cement dust on respiratory function of non-smoking cement mill workers. Int J Environ Res Public Health.10(1), 390-398.

34. Akinola M., Okwok N., Yahaya T., 2008. The effects of cement dust on albino rats around West African Portland cement factory in Sagamu, Ogun state, Nigeria. RJET. 2, 1-8.

35. Rumack B.H., Hall A.H. Information System Micromedex, Inc. Englewood, CO. CCIS Volume 169. Toxicology Data Network, National Library of Medicine: Maryland, 2016.

36. Manoharan N.V., Miltonprabu S., 2015. Cadmium induced cardiac oxidative stress in rats and its attenuation by GSP through the activation of NrF2 signalling pathway. Chem Biol Interact. 242, 179–193.

37. Bagale K.R., Ingle A.S., Choudhary R., 2016. Contribution of various lipid profile parameters in determining creatine kinase-MB levels in unstable angina patients. Int J Appl Basic Med Res. 6(2), 106-110.

38. Iyawe V.I., Ebomoyı M.I.E., Chıwuzıe J.C., Alakıja W., 2000. Some factors whıch may affect blood pressure ın nıgerıan cement factory workers. Afr J Biomed Res. 3, 117 – 121.