

Effect of Cement Dust Exposure duration on Liver Function Parameters in Cement Factory Workers

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Abstract

Background: Production of cement is a dusty industrial process which includes emission of particulates, gases, solid waste, etc. Cement industries are regarded as one of the major source of environmental pollution. Cement factory workers are prone to occupational hazards. They encounter detrimental impact on their health due to prolong and repeated exposure to cement dust. This study was aimed at evaluating the effect of cement dust exposure duration on liver function parameters (Serum bilirubin, alanine aminotransferase, aspartate aminotransferase and alkaline phosphatase) in cement factory workers.

Materials and methods: Cross-sectional comparative study design was adopted in this work. It was conducted in Department of Physiology, Chittagong Medical College in collaboration with Confidence cement factory Ltd. Chattogram from July 2022 to June 2023. Apparently healthy total 96 male subjects, aged between 20-50 years with BMI 18.5-27.5kg/m² were included in this study by simple random sampling using lottery technique. Among them 48 cement factory workers, who were directly exposed to cement dust for at least 5 years and 48 subjects, engaged in desk job/office work, not directly exposed to cement dust in their working environment were enrolled in this study. To assess liver function serum ALT, AST, ALP and serum bilirubin were estimated. Unpaired Student's t-test and ANOVA test were done for statistical analysis.

Results: Mean values of serum ALT and AST were significantly higher in workers exposed for 10-14 years. Other parameters showed non significant changes between groups.

Conclusion: The results of this study suggests that duration of exposure to cement dust might not cause significant differences in the liver function of cement factory workers.

Key words: Cement dust; Environmental pollution; Liver function; Occupational hazards.

INTRODUCTION

Cement industry is one of the major source of environmental pollution worldwide.^{1,2} The particulates and dust released during various stages of cement manufacturing exert adverse impact on the environment.^{2,3} Cement dust is considered as the major pollutant emitted during cement manufacture.^{1,3} Occupational health hazards to workers induced by cement dust include-respiratory diseases, haematological complications, vision problem, brain and organ damage, genetic disorder and teratogenic effect.^{1,2,4}

Liver is the main organ involved in metabolism of drugs and detoxification of exogenous and endogenous toxic agents.^{5,6} Evidence showed liver is mostly affected by industrial toxic agents.⁵

Liver disease accounts for approximately 2 million deaths per year worldwide. In 2020 mortality rate due to liver disease has reached 2.94% of total deaths in Bangladesh.⁷

Cement contains different heavy metals with their oxides and other impurities are also present.^{4,8}

Previous researchers observed that exposure to cement dust may induce imbalance between biological oxidant and antioxidant ratio. It causes oxidative damage to different organs including liver.⁸ Several researchers evaluated effect of cement dust exposure on selected liver function parameters in cement factory workers. They observed significant increase in liver enzymes; ALT, AST in workers ($p < 0.05$).⁹⁻¹⁵ Others found significant decrease in liver enzymes in their study.^{16,17} They supposed survival in chemically hostile environment is facilitated by induction of enzymes to detoxify different toxins and chemicals.¹⁴

According to researcher, exposure to particulate matters and gases (SO_2 , NO_2) triggers oxidative stress and an inflammatory response, which contributes to abnormal hepatic function.¹⁸

Liver function parameters were changed with duration of exposure. Plasma bilirubin and ALT was significantly higher in cement workers working for 1-20 years. But AST and ALP activities were unchanged in both exposed and un-exposed groups. They supposed that chronic exposure to cement dust for first 15 years may exert deleterious effects on liver. Decreased bilirubin after 20 years might be due to adaptive response.¹⁹

Studies are available on liver function and cement dust exposure, but most of the studies were conducted without considering the long term duration response effect between years of exposure and liver function impairment. Therefore, present study aimed to assess the magnitude of health risks posed by long term cement dust exposure on selected liver function in cement factory workers.

MATERIALS AND METHODS

This is a comparative cross-sectional study conducted in the Department of Physiology, Chittagong Medical College in collaboration with Confidence cement factory Ltd. Chattogram from July 2022 to June 2023.

Simple random sampling using lottery technique.

Ethical clearance for the study was given by Ethical review committee of Chittagong Medical College, Chattogram. Permission from respective authority was taken prior to conduct this study. All subjects included in the study was informed and explained about the study. Written informed consent was taken.

Total 96 male subjects were included in this study. Among them 48 subjects, age 20-50 years, occupationally exposed to cement dust for at least 5 years and working in cement factory for at least 8-10 hours a day, for six days per week were grouped as exposed group. 48 subjects working in administrative office/ in the desk in the same factory not directly exposed to cement dust were grouped as un-exposed group.

These selected workers cut across five sections of the production and packaging processes. Namely, raw material crushing and processing, milling, packing of raw materials, storage and transportation, clinker production, These categories of workers were selected because of the various degree of exposure to cement particulates. Based on the duration of exposure, cement mill workers were divided into three groups, 5-9, 10-14 and ≥ 15 years. All subjects were individually matched for age, height, weight and BMI.

The data of the selected respondents were collected by interview administered structured data collection sheet covering history of employment, socioeconomic status, work experience, use and non-use of personal protective gadgets. Information on respondents' wellness and history of past illness were also obtained. Database for the study was designed and statistical package for social sciences (Version 27) was used for data analysis. Inferential statistics such as analysis of variance (ANOVA) and unpaired Student's t-test was used to test the hypotheses at $p < 0.05$.

Exclusion criteria

- Age: < 20 Years and > 50 Years.
- Exposure to cement dust Subjects exposed to cement dust < 5 years and < 8 hours/day
- History of previous exposure or concurrent exposure to other occupational toxicants.
- History of any systemic diseases like liver disease, asthma, diabetes, hypertension, anemia, cancer, infections, thyroid and Cardiac disease.
- Subjects with recent history of blood transfusion.
- History of drug addiction, alcohol addiction, exposure to deadly substances, therapy with antioxidants or drugs or radiation were not included in the study.

Blood samples were collected using the venipuncture technique. Venous blood (4mL) was lastly drawn into plain vacutainer bottles for the evaluation of Serum bilirubin, alanine aminotransferase, aspartate aminotransferase and alkaline phosphatase. All drawn samples were conveyed to Epic health care for analysis within 1-2 hours, maintaining cold chain (Crushed ice in air-tight and sealed thermo-container).

Data generated from the study were analyzed for descriptive statistics (Mean and standard deviation). ANOVA and unpaired Student's t-test were used as test of significance.

RESULTS

Table I Comparison of general characteristics of Respondents (n=96)

Variables	Exposed (n=48)	Un-exposed (n=48)	p-value
	Mean \pm SD (Range)	(Mean \pm SD) (Range)	
Age (Years)	36.5 \pm 6.9 (24 -49)	36.2 \pm 7.6 (24 -50)	0.955ns
Height (m)	1.65 \pm 0.59 (1.42 -1.80)	1.64 \pm 0.54 (1.47 -1.75)	0.734ns
Weight (Kg)	65.5 \pm 8.14 (48 -89)	64.45 \pm 9.73 (48 -82)	0.565ns
BMI (Kg/m ²)	24.1 \pm 2.0 (19.9 -27.4)	23.7 \pm 2.5 (19.5 -27.1)	0.405ns

Unpaired Student's t-test was done. Values are expressed as Mean±SD (Standard Deviation) n: number of subjects, ns: not significant ($p>0.05$) values in parenthesis indicate range, BMI: Body Mass Index.

Table II Comparison of liver function of cement dust exposed and un-exposed group with duration of exposure less than 10 years (5-9 years) (n=40)

Variables	Exposed (n=20)	Un-exposed (n=20)	p-value
	Mean ± SD (Range)	Mean ±SD (Range)	
SerumALT (U/L)	46.25 ± 16.11 (28 -82)	38.7 ±16.0 (19 -100)	0.121ns
SerumAST (U/L)	27.15 ± 9.81 (10 -58)	22.5 ±5.7 (14 -28)	0.05ns
SerumALP (U/L)	83.85 ± 15.72 (50 -118)	83.96 ±17.4 (14 -114)	0.982ns
Serum bilirubin (mg/dL)	0.61 ±0.34 (0.23 -1.30)	0.48 ±0.17 (0.26 -0.75)	0.108ns

Unpaired Student's T-test was done. Values are expressed as Mean±SD (Standard Deviation) n: number of subjects, ALT= Alanine Aminotransferase, AST=Aspartate Aminotransferase, ALP=Alkaline Phosphatase, SD=Standard Deviation, ns=Statistically not significant ($p>0.05$).

Table III Comparison of liver function of cement dust exposed and un-exposed group with duration of exposure less than 15 years (10-14 years) (n= 40)

Variables	Exposed (n=20)	Un-exposed (n=20)	p-value
	Mean ± SD (Range)	Mean ±SD (Range)	
SerumALT (U/L)	58.80 ± 28.88 (27 -140)	40.46 ± 16.8 (26 -84)	0.046*
SerumAST (U/L)	29.55 ± 9.68 (15 -50)	22.08 ± 6.3 (13 -35)	0.020*
SerumALP (U/L)	78.00 ± 21.51 (12 -59)	74.85 ± 8.8 (56 -90)	0.621ns
Serum bilirubin (mg/dL)	0.56 ±0.35 (0.20 -1.66)	0.59 ± 0.38 (0.16 -1.30)	0.834ns

Unpaired Student's T-test was done. Values are expressed as Mean±SD (Standard Deviation) n : number of subjects, ALT=Alanine Aminotransferase, AST=Aspartate Aminotransferase, ALP=Alkaline Phosphatase, SD=Standard Deviation, *=Statistically significant, ns=Statistically not significant ($p>0.05$).

Table IV Comparison of liver function of cement dust exposed and un-exposed group with duration of exposure for ≥15 years (n=16)

Variables	Exposed (n= 8)	Un-exposed (n= 8)	p-value
	Mean ± SD (Range)	Mean ± SD (Range)	
SerumALT (U/L)	45.00 ± 16.00 (21 -72)	48.89 ±31.9 (22 -125)	0.761ns
SerumAST (U/L)	26.13 ± 14.74 (12 -59)	23.3 ±11.1 (14 -48)	0.663ns
SerumALP (U/L)	68.50 ± 15.50 (51 -93)	85.22 ±13.9 (64 -111)	0.03*
Serum bilirubin (mg/dL)	0.47 ±0.31 (0.23 -1.62)	0.67 ±0.37 (0.23 -1.5)	0.248ns

Unpaired Student's T-test was done. Values are expressed as Mean±SD (Standard Deviation) n : number of subjects, ALT=Alanine Aminotransferase, AST=Aspartate Aminotransferase, ALP=Alkaline Phosphatase, SD=Standard Deviation, *=Statistically significant, ns=Statistically not significant ($p>0.05$).

Table V Changes in liver function in relation to duration of exposure in cement dust exposed group (n=48)

Variables	Duration of exposure to cement dust			p-value
	5-9 years (n=20)	10-14 years (n=20)	≥ 15 years (n= 8)	
	Mean ± SD (Range)	Mean ± SD (Range)	Mean ± SD (Range)	
SerumALT (U/L)	46.25 ± 16.11 (28 -82)	58.80 ± 28.88 (27 -140)	45.00 ± 16.00 (21 -72)	0.151ns
SerumAST (U/L)	27.15 ± 9.81 (10 -58)	29.55 ± 9.68 (15 -50)	26.13 ± 14.74 (12 -59)	0.675ns
SerumALP (U/L)	83.85 ± 15.72 (50 -118)	78.00 ± 21.51 (12 -59)	68.50 ± 15.50 (51 -93)	0.143ns
Serum bilirubin (mg/dL)	0.61 ± 0.34 (0.23 -1.30)	0.56 ± 0.35 (0.20 -1.66)	0.47 ± 0.31 (0.23 -1.62)	0.640ns

ANOVA (F test) test was done. ALT=Alanine Aminotransferase, AST=Aspartate Aminotransferase, ALP=Alkaline Phosphatase, SD=Standard Deviation, ns=Statistically not significant ($p>0.05$).

DISCUSSION

Age and BMI matched ($P>0.05$) 96 subjects were enrolled in this study, among them 48 Cement factory workers, directly exposed to cement dust were taken as cement dust exposed group. 48 workers working in the administrative office of the same factory, not directly exposed to cement dust were selected as cement dust un-exposed group.

Mean duration of employment were similar in both exposed and un-exposed workers. On average they worked for 8-10 hours/day in a week with a off day. They reported about occasional use of protective measures. Based on the duration of exposure, the workers were divided into three groups, 5-9, 10-14 and ≥15 years.

Exposed workers for 10-14 years, showed a significant rise in serum ALT and AST in comparison to un-exposed group (Table III). Current study finding is suggestive of liver function impairment. Researchers supposed that several toxic metabolites are generated during metabolism of cement dust component which may cause hepatic malfunction.⁵

Cement dust exposed workers for ≥ 15 years showed as ignificant reduction in serum ALP relative to matched cement dust un-exposed group (Table IV).

This observed decline in serum ALP among long-term cement dust-exposed workers simulates with some previous studies.^{6,13} ALP is a zinc-dependent enzyme. Cement dust may reduce bio-available zinc, either by interfering with gut absorption or through inflammation. This deficiency could lead to a functional reduction in serum ALP activity. Besides this, chronic malnutrition, micro-nutrient deficiency, hypothyroidism may also contribute to reduction in ALP.²⁰

No significant difference was observed in liver function test parameter with duration of exposure in exposed group. Mean values of all the parameters were similar among three groups based on their duration of cement dust exposure ($p>0.05$). All the values were decreased with increase in duration of exposure over 15 years (Table V).

This finding simulates with some researchers.^{19,21} Opposite finding was revealed by some authors.¹⁴ It is supposed that, their immune system might be adapted with increasing duration of exposure.¹⁹ Significant increase in serum ALT, AST and ALP with duration of exposure was observed by previous researchers.¹⁴ □

In their study, they observed exposed workers were daily workers without any off day. It was supposed working for longer duration might increase physical and psychosocial stress.^{22,23} Researchers supposed that stress adversely affect liver. It may induce inflammatory change in the liver. There might be over production of stress hormone by activation of hypothalamo-pituitary-adrenal axis or sympathetic nervous system.²² Stress might cause increase fat accumulation in liver and loss of hepatic regeneration capacity, resulting in liver damage.²⁴

Decrease in RBCs count and Hb% were observed by Al-Shamery et al. with increasing exposure periods. That was supposed to be due to the effect of cement dust on haematopoietic system.²⁵

It could be the possible cause of insignificant decrease of bilirubin with duration of exposure.

RECOMMENDATIONS

Use of appropriate safety gadgets and intake of anti oxidant by all workers may be effective in reducing cement dust related health hazards. It is also suggested that workers must undergo pre-employment and periodic health check up including liver function test. Therefore, long term exposure to cement industries should be evaded and workers must be given official days off.

CONCLUSION

The study revealed that duration of exposure to cement dust may not significantly change the liver function of cement factory workers. Although, serum ALT and AST levels were significantly increased in workers exposed for 10-14 years.

LIMITATIONS

The limitations of the present study include lack of specific dust exposure assessment and the relatively small sample size.

DISCLOSURE

All the authors declared no competing interest.

REFERENCES

- Singh S. Occupational Health Hazards in Cement Plant Workers and Their Remedies. *Nature, Environment and Pollution Technology*. 2010;9(2):443-446.
- Sana S, Bhat GA, Balkhi HM. Health risks associated with workers in cement factories. *International journal of scientific and research publications*. 2013May;3(5):2250-3153.
- Adeniran JA, Yusuf RO, Fakinle BS, Sonibare JA. Air quality assessment and modelling of pollutants emission from a major cement plant complex in Nigeria. *Atmospheric Pollution Research*. 2019;10(1):257-266.
- Ahmad R, Akhter QS, Haque M. Occupational cement dust exposure and inflammatory nemesis: Bangladesh relevance. *Journal of Inflammation Research*. 2021;14:2425.
- Tirumalaraju S, Lakkaraju C, Reddy PP, Mundluru HP, CH P. Study on the effect of Industrial Pollution on Liver Profile in People Living in and Around Industrial Areas. *Int. J. of Multidisciplinary and Current research*. 2016v;4:1147-1151.
- Poormohammadi A, Ghane ET, Moeini ES, Bashirian S, Motavallihaghi S, Mehri F. Evaluation of oxidative stress biomarkers and liver enzyme activity in workers occupationally exposed to respirable free crystalline silica. *Journal of Air Pollution and Health*. 2023;8(1):77-86.
- Liver disease in Bangladesh-World Life Expectancy. 2023. <https://www.worldlife-expectancy.com/bangladesh-liver-disease>
- Al Salhen KS. Assessment of oxidative stress, haematological, kidney and liver function parameters of Libyacement factory workers. *Journal of American science*. 2014;10(5):58-65.
- Aydin S, Aral I, Kilic N, Bakan I, Aydin S, Erman F. The level of antioxidant enzymes, plasma vitamins Cand E in cement plant workers. *Clinica chimica acta*. 2004;341(1-2):193-198.
- Ogunbileje JO, Akinosun OM, Arinola OG, Akinduti PA. Immunoglobulin classes (IgG, IgA, IgM and IgE) and liver function tests in Nigerian cement factory workers. *Researcher*. 2010;2(4):55-58.
- Mohammadirad A, Abdollahi M. A systematic review on oxidant/antioxidant imbalance in aluminium toxicity. *Int J Pharmacol*. 2011;7(1):12-21.
- Jasim RH, Numan AW, Hasan SM. Evaluation of oxidative stress and liver function parameters in the sera samples of Kufa cement factory workers. *Journal of Kufa for Chemical Science*. 2012;6(5):40-50.
- Sameen AM. Study the effect of cement dust exposure on liver and kidney parameters in some cement field workers in Al-Ramadi City. *J. of university of Anbar for pure science*. 2013;7(2).
- Emmanuel TF, Okaka AN, Ibaim UA, Sonni M. The toxicological effect of cement dust on hepatic and renal functions of cement factory workers. *Int. J. LifeScs. Research*. 2017;5(3):37-45.

REFERENCES

15. □ Richard EE, Augusta Chinyere NA, Jeremiaah OS, Opara UC, Henrieta EM, Ifunanya ED. Cement dust exposure and perturbations in some elements and lung and liver functions of cement factory workers. *Journal of toxicology*. 2016;2016.
16. □ Mojiminiyi FB, Merenu IA, Ibrahim MT, Njoku CH. The effect of cement dust exposure on haematological and liver function parameters of cement factory workers in Sokoto, Nigeria. *Nigerian journal of physiological sciences*. 2008;23(1-2):111-114.
17. □ Priya SD, Suja S, Sharmila S. Immunoglobulin classes (IgG, IgA, IgM and IgE) and liver function tests in workers occupationally exposed to cement dust. *Journal of Pharmacy Research*. 2011;4(10):3590-3592.
18. □ Dey T, Gogoi K, Unni B, Bharadwaz M, Kalita M, Ozah D, Kalita M, Kalita J, Baruah PK, Bora T. Role of environmental pollutants in liver physiology: Special references to peoples living in the oil drilling sites of Assam. *PloSone*. 2015;10(4):e0123370.
19. □ Festus OO, Agbebaku SO, Idonije BO, Oluba OM. Influence of Cement Dust Exposure on Indicators of Hepatic Function in Male Cement Handlers in Ekpoma, Nigeria. *Electronic Journal of Medical and Educational Technologies*. 2021;14(2):em2104.
20. □ Ray CS, Singh B, Jenal, Behera S, Ray S. Low alkaline phosphatase (ALP) in adult population an indicator of zinc (Zn) and magnesium (Mg) deficiency. *Current Research in Nutrition and Food Science Journal*. 2017;5(3):347-352.
21. □ Mandal A, Paul S. Liver enzyme status and cardiovascular parameters of construction workers from West Bengal, India. *Journal of Human Ergology*. 2016;45(2):33-47.
22. □ Joung JY, Cho JH, Kim YH, Choi SH, Son CG. A literature review for the mechanisms of stress-induced liver injury *Brain and behavior*. 2019;9(3):e01235.
23. □ Vere CC, Streba CT, Streba LM, Ionescu AG, Sima F. Psychosocial stress and liver disease status. *World journal of gastroenterology: WJG*. 2009;15(24):2980-2986.
24. □ Ishtiaq SM, Khan JA, Arshad MI. Psychosocial-stress, liver regeneration and weight gain: A conspicuous pathophysiological triad. *Cellular Physiology and Biochemistry*. 2018 Apr 24;46(1):1-8.
24. □ Al-Shamery HA, Jankeer MH. Study the effect of cement dust exposure on the hematological variables in the workers of new badoosh cement factory in Mosul city, Iraq. In *Journal of Physics: Conference Series*. 2021;1999(1):12030.