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Original Article

Effect of Cement Pollution on Serum Creatinine and Blood Urea in Cement Factory Workers

Md. Mujahidul Islam[1*]
Shahin Akhter[2]
Shaheda Khanam[1]
Taslima Nasrin[3]
Aindrila Das Gupta[4]
Supriya Das[5]

[1]Department of Physiology
Chattagram Maa-O-Shishu Hospital Medical College
Chattogram, Bangladesh.

[2]Department of Physiology
Chittagong Medical College
Chattogram, Bangladesh.

[3]Upazila Health Complex
Fatikchari, Chattogram, Bangladesh.

[4]Department of Physiology
Chittagong Medical College
Chattogram, Bangladesh.

[5]OSD, DGHS
Dhaka, Bangladesh.

Background: *Cement dust is one of the major air pollutants and its exposure causes multiple health hazards. It can invade human body through different routes and enter into systemic circulation which affects microstructure of different organ like liver, lung and kidney. Aim of this study was to assess the effect of cement pollution onserum creatinine and blood urea in cement factory workers of Chattogram City.*

Materials and methods: *This was ananalytical (Comparative) cross-sectional studyconducted from July 2022 to June 2023 in the Department of Physiology, Chittagong Medical College, Chattogram. Total 76 male subjects aged between 20-50 years were included in this study by simple random sampling. 38 workers of selected cement factory in Chattogram who were directly exposed to cement dust and another age and BMI matched apparently healthy 38 subjects who were not directly exposed to cement dust in their working environment were enrolled in this study. Serum creatinine and blood urea were assessed for kidney function. Unpaired student's t-test and Pearson's correlation coefficienttest were done for statistical analysis.*

Results: *Mean value of serum creatinine was significantly higher in cement dust exposed group in comparison to unexposed group ($p<0.05$). Blood urea showed no significant changes when compared between two selected groups ($p>0.05$). No significant changes were observed in serum creatinine and blood urea regarding duration of exposure to cement dust. There were no significant correlation between serum creatinine and blood urea with duration of job exposure ($p>0.05$).*

Conclusion: *The result of this study concludes that exposure to cement dust significantly alter serum creatinine level.*

Key words: Blood Urea; BMI; Cement pollution; Directly exposed; Kidney function; Serum creatinine.

INTRODUCTION

Cement is an essential component of basic structural development and most important for construction industry due to constant urban movement.[1,2] It is necessary for the country's socioeconomic growth and development.[2] The demand for cement is increasing day by day resulting in a rapid growth of cement industry.[3]

In Bangladesh 76 cement manufacturing companies were registered, but 42 plants are currently in operation.[4] The section in cement factory can be grouped into crushing, milling, packing, raw material handling, clinker production, storage and conveyors departments and each of those departments are known to differ in releasing different toxic constituents.[5,6]

*Correspondence to:
Dr. Md. Mujahidul Islam
Lecturer
Department of Physiology
Chattagram Maa-O-Shishu Hospital Medical College
Chattogram, Bangladesh.
Mobile : +88 01672 94 67 95
Email : md.mujahidulislam88@gmail.com

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Cement is a mixture of different substances including 60-70% calcium oxide, 17-25% silicon oxide, 3-5% aluminium oxide. Beside these some amount of iron, chromium, potassium, sodium, sulphur, magnesium, cadmium and thallium are emitted during production.[7,8,9] Cement dust is a grey powder produced from contaminated clay, limestone having diameter ranging from 0.05-5.0 micrometer.[5] Three types of air pollutants are released into air during cement production including Particulate Matter (PM) Nitrogen Oxide (NOX) and sulfur dioxide (SO_2).[10] As dust and particulate matter are being released from various stages of cement production, cement factories have been viewed as one of the major sources of air pollution.[11]

In most of the countries cement – specific limits for dust are <100 mg/Nm^3. It is the common unit used in industry which referring gas emission or exchange.[12,13] In Bangladesh it is ≤200mg/Nm^3.[14]Millions of people are working in cement industry. They face different toxic components which causes multiple health hazards.[15] Cement dust and its gasses can enter into human body through different routes such as inhalation; ingestion and absorption through skin.[3]It causes hematological and cytogenic damage among cement workers.[16]Cement dust disturbs the antioxidant potential of the body.[15] Chronic exposure to these pollutants increases free radical (ROS) production which causes damage to cellular membrane with alteration of cellular functions, ultimately damages different tissues and organ.[17]

Toxic substances like aluminum, silica, and chromium at work can trigger inflammatory changes in multiple organs.[18]It has harmful effect on the renal structure, tubular brush border. It also causes hemorrhagic alterations in the glomerular area and epithelial protrusion towards the tubular lumens[8]and there is increased incidence of chronic kidney disease and end stage renal disease in workers exposed to crystalline silica.[19] Lipid peroxidation upon chronic aluminum exposure can lead to kidney failure, toxic changes in the nervous system.Experiments over rats exposed to cement dust showed histological changes in lung, liver and kidney tissues due to toxic elements in the cement dust. The kidney tissue showed inflammatory changes. It also showed damaged epithelial lining, convoluted tubules and renal corpuscles.[20]

Several authors observed significant increase in serum creatinine level in cement workers comparing to control group.[7,8,21] Multiple researchers showed significant increase in blood urea in cement exposed workers in contrast with unexposed group and this increased urea level directly proportional with exposure time.[9,15,21] Possible reason of raised urea level might be due to the tendency of urea enhancing protein catabolism. Also malfunctioning in glomerular filtration might be another cause of raised urea level.[9]

There is scarce study on kidney function parameters (Serum creatinine and blood urea) in Bangladesh. So the present study aimed to assess the potential impact of cement dust on kidney by measuring serum creatinine and blood urea in chattogram, Bangladesh.

MATERIALS AND METHODS

This analytical (Comparative) cross-sectional study was conducted in the Department of Physiology, Chittagong Medical College, Chattogram. Total 76 male subjects aged between 20-50 years were included in this study by simple random sampling using lottery technique. Among them 38 cement factory workers were selected, who were directly exposed to cement dust and another age and BMI matched apparently healthy 38 subjects who were not directly exposed to cement dust in their working environment were enrolled in this study. Ethical clearance of this study was given by Ethical Committee of Chittagong Medical College. Permission from Chittagong Medical College authority and also the cement factory (Confidence Cement PLC Bhatiari, Chattogram) authority was taken prior to data collection. Informed written consent was taken from each subject. A structured data collection sheet was filled in up by researcher himself. Information about age of workers, duration of job, site and position of workplace, use of safety gadget, information of general health, history of past disease and smoking habits were collected by interviewing. Information was recorded in case record form and an ID number was given to each subject.For the purpose of exclusion, history of any disease such as acute or chronic kidney disease, respiratory disease, cardiovascular disease, liver disease, history of taking any nephrotoxic drugs, recent history of diarrhoeal illness were taken. General examination was done to see general physical condition of the subjects. After screening by inclusion and exclusion criteria, 78 subjects were recruited into this study.

Values of serum creatinine, blood urea were measured in subjects. Data was analyzed by SPSS-26. Quantitative or continuous data was expressed as mean ± Standard Deviation (SD). Categorical variables were presented as frequency and percentage. Unpaired Student's 't' test was used to compare the mean of quantitative variables between two groups. Pearson's correlation coefficient test was used to assess the correlation between two quantitative variables. $p < 0.05$ was considered statistically significant.

RESULTS

Table I General characteristics of the Respondents (n= 76)

Characteristics	Exposed Group (n=38) Mean ± SD (Range)	Unexposed Group (n=38) Mean ± SD (Range)	p value
Age (Years)	36.9 ± 7.4 (24-48)	36.9 ± 7.4 (24-48)	1.0 NS
BMI(kg/m^2)	24.3 ± 1.9 (19.6-27.4)	23.7 ± 2.6 (19.5-27.1)	0.234 NS
SBP(mm of Hg)	119.7 ± 11.5 (100-138)	118.6 ± 11.9 (90-135)	0.674 NS
DBP(mm of Hg)	78.3 ± 4.4 (70-90)	76.7 ± 5.9 (60-85)	0.193 NS

SD: Standard Deviation, n= number of subject, BMI: Body Mass Index, SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure. NS: Statistically Not Significant (p>0.05), p value obtained by Unpaired Student's 't' test.

Table I shows there was no significant difference in age, BMI, systolic and diastolic blood pressure, between two groups (p value >0.05). Therefore, both groups were matched for above mentioned each variable.

Table II Comparison of serum creatinine and blood urea between exposed and unexposed groups (n= 76)

Chracteristics	Exposed group (n=38) Mean ± SD (Range)	Unexposed Group (n=38) Mean ± SD (Range)	p value
Serum creatinine (mg/dl)	0.93 ± 0.10 (0.76-1.29)	0.86 ± 0.13 (0.58-1.20)	0.012^{S}
Blood urea (gm/dl)	19.95 ± 4.62 (9.0-28.0)	21.08 ± 5.52 (12.0-38.0)	0.336^{NS}

SD: Standard Deviation, n= number of subject, S: Statistically Significant (p>0.05), NS: Statistically Not Significant (p>0.05), p value obtained by UnpairedStudent's 't' test.

Table II shows mean serum creatinine level was significantly higher in exposed group than the unexposed group (p<0.05). The mean differences of blood urea level were not statistically between the group (p>0.05).

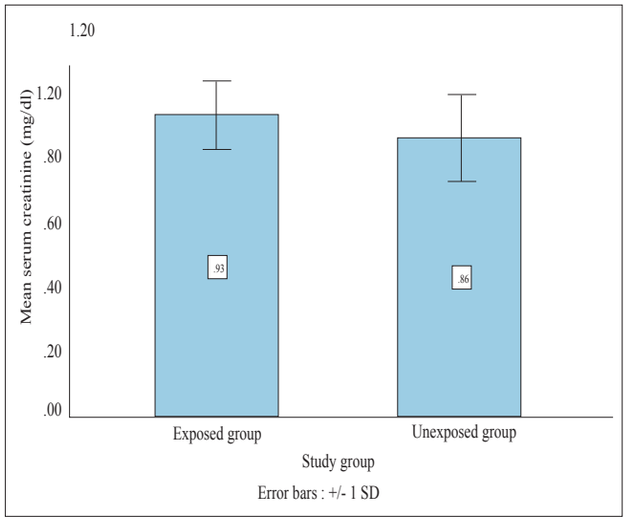

Figure 1 Bar diagram with error bars: Mean (±SD) serum creatinine levels between exposed and unexposed group

Figure 1 shows mean serum creatinine level was 0.93 ± 0.10 and 0.86 ± 0.13 mg/dl in exposed and unexposed group respectively which was significant statistically (p=0.012).

Table III Effect of cement dust on serum creatinine and blood urea in relation to duration of exposure to cement dust in exposed group (n= 38)

Paramters	5-10 years Mean ± SD (Range) (n= 21)	>10 years Mean ± SD (Range) (n= 17)	p value
Serum creatinine (mg/dl)	0.90 ± 0.09 (0.76-1.29)	0.95 ± 0.12 (0.77-1.27)	0.160^{NS}
Blood urea (gm/dl)	20.81 ± 4.22 (14.0-28.0)	18.88 ± 4.999 (9.0-27.0)	0.205^{NS}

SD: Standard Deviation, n= number of subject, NS: Statistically Not Significant (p>0.05), p value obtained by Unpaired Student's 't' test.

Table III shows there is no significant difference in mean serum creatinine and blood urea level based on their cement dust exposure duration (p>0.05).

Table IV Correlation of serum creatinine and blood urea with job exposure duration in exposed group (n=38)

Kidney function parameters	Exposure duration, years r value	p value
Serum creatinine (mg/dl)	0.206	0.215
Blood urea (gm/dl)	-0.049	0.770

Pearson'scorrelation coefficient test was done.

Table IV shows there was a non-significant positive correlation between duration of exposure and serum creatinine level (r=0.206, p=0.215) and non-significant negative correlation between duration of exposure and blood urea level in the exposed group (r=-0.049, p=0.77).

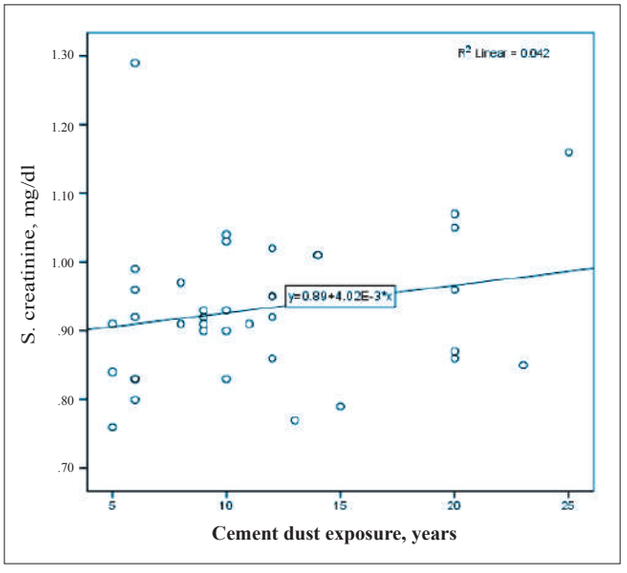

Figure 2 Correlation between duration of cement dust exposure and serum creatinine level.

DISCUSSION

Age and BMI matched (p>0.05) 76 subjects were enrolled in this study among which 38 subjects were exposed directly to cement dust and 38 subjects were not exposed to cement dust (Table I). Mean serum creatinine level was 0.93 ± 0.10 and 0.86 ± 0.13 mg/dl in the exposed and unexposed group respectively in the present study.

This study showed that the mean serum creatinine level was significantly higher in the exposed group than in the unexposed group (p 0.05) but within the normal range (Table II, Figure 1). These findings are consistent with other studies[1,7,15,21] where they found significantly higher value in cement workers but the value is within normal range. Among them some researchers found the value of serum creatinine is above normal range.[8] Present study findings regarding serum creatinine level aredissimilar with some previous studies.[9,17,22] Al Salhen found increased level of serum creatinine in exposed workers than controls but the difference was not statistically significant.[17] In another study a lower mean serum creatinine level was observed among cement factory workers than the controls but the difference was not significant statistically.[22] The dissimilar result suggests that the kidney may not be adversely affected by cement dust exposure.[17]

In this study mean blood urea was not significantstatistically (p>0.05) (Table II). The findingswere simulates with some previous studies.[11,17,22,23] The results were dissimulates with multiple studies where they found significantly higher blood urea levels in exposed group than unexposed group.[1,7,9,21] They suggested this rises might be due to urea enhancing protein catabolism together with accelerated amino acid deamination for gluconeogenesis.[9]

In the present study the mean differences of serum creatinine and blood urea levels were not significant statistically between workers working in cement factory for 5 to 10 years and ≥ 10 years in the present study (p>0.05) (Table III). Some researchers who foundsignificant increase in serum creatinine and blood urea level in workers exposed to dust for longer period of exposure.[9,11] They supposed that the long term effect of cement dust exposure is the reason behind this. In the present study more than half of the workers had history of cement dust exposure for less than 10 years and only 2 out of 38 exposed cases had exposure for more than 20 years. On the other hand, in the study of Hakim et al.more than half of the workerswere exposed to cement dust for more than 20 years.[24] Less duration of exposure is the probable reason behind these non-significant findings in this study.

The present study shows a non-significant positive correlation between the duration of exposure and serum creatinine level in the exposed group (r=0.206, p=0.215) (Table-IV, Figure 2) and a non-significant negative correlation between the duration of exposure and blood urea level in the exposed group (r=-0.049, p=0.77) (Table-IV).

Several researchers showed multiple probable mechanisms for alteration of kidney function parameters. Some researchers suggestedthat significant increase in creatinine level is due to nephrotoxic effect of cement dust in exposed group.[7] It also might be due to renal insufficiency caused by silica which also causes histological changes in tubular brush border, hemorrhagic alteration in the glomerular area. Another possible reason for the increase creatinine level might be due to nephrotoxic effect caused by cadmium released during cement dust production.[8,21] Some researchers showed that components of cement dust such as chromium, silica, and aluminium can cause production of free radicals and oxidative stress which can cause toxic effects on kidney function.They also reported silica exposure is being associated with renal insufficiency.[7,17] In present study significant increase in serum creatininelevel in exposed group might be due tooccupational exposure of thecomponents of cement dust.

Regarding blood urea level some researchers suggests that kidney may not be adversely affected by cement dust exposure.[17]Blood urea level shows non-significant difference in this study. Small sample size and occasional use of personal protective measure by the cement workers might be the reason of this study finding.

LIMITATION

The limitations of this study are-

- Cross-sectional study with relativelysmall sample size.
- Short period of study.
- Not equal years of exposure history in service.

CONCLUSION

The study concludes that, mean value of serum creatinine was significantly higher in cement dust exposed group in comparison to unexposed group. The findings are important as they emphasize the need to overcome the effects of exposure. Periodical regular interval assessment of serum creatinine level can help in diagnosis of any kidney function alteration in initial stage. Cement factory authority should maintain dust control system on regular basis and provide proper personal protective equipment to ensure adequate protection of the workers. Thus productivity of workers can be increased.

DISCLOSURE

All the authors declared no competing interest.

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