Effect of Cement Pollution on Creatinine and Blood Urea in Hamam Al-Alil Factory Workers

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Abstract:

The present study investigate the effects on 55 workers which were divided into groups according to the departments of Hamam AL-Alil Cement Factory-Iraq. The parameters included in the study are: potassium, sodium, blood urea, BUN, and creatinine.

The results showed that there was a significant increase in sodium, blood urea and BUN in workers serum which increased with increasing exposure time. The results also showed a significant decrease in potassium in workers serum which increased with increasing exposure time in all factory department. Whereas the creatinine illustrate no significant decrease with increasing exposure time.

تأثير ملوثات الأسمنت على فعالية الكرياتنين ويوريا الدم في عاملي أسمنت
حمام العليل

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ملخص البحث:

تضمنت الدراسة البحث في تأثير ملوثات الأسمنت على 55 عاملاً الذين تم توزيعهم على مجاميع بحسب مواقع عملهم في معمل سمنت حمام العليل– العراق. وقد تم في هذه الدراسة قياس البوتاسيوم والصوديوم ويوريا الدم ونتروجين يوريا الدم والكرياتنين.

أظهرت النتائج بأن هنالك زيادة معنوية في كل من مستوى ايونات الصوديوم ويوريا الدم ونتروجين يوريا الدم مع انخفاض معنوي في مستوى ايونات البوتاسيوم في حين أعطى الكرياتنين انخفاض غير معنوي في مصل دم العاملين مع ازدياد فترة التعرض.

Introduction:

Portland cement is composed of tri-calcium silicate, di-calcium silicate, tri-calcium aluminate, tetra-calcium aluminoferrate and gypsum, with trace constituents like potassium oxide, sodium oxide, chromium compound and nickel compound (Adamu and Iloba, 2008).

Cement industry is one of the most pollutant industries due to large quantities of its gas emissions and dust (Lioy *et al.*, 2002). The major gaseous emissions are nitrogen oxides (NO_x) and sulfur oxides (SO_2). Other emissions of less significance are carbon dioxide (CO_2), thallium, ammonia and heavy metals (Carrasco *et al.*, 2002). And the composition of dust can be greatly diversified due to a great variety of materials used at the different stages that lead to cement production, like raw material grinding, coal mills, rotary kilns, clinker cooling, finished grinding, silos and packaging (Somma *et al.*, 2006).

All process involving potential exposure to hazardous substances may cause harm as a result of intake of the substances into the body, by inhalation through the respiratory tract, by ingestion, or through the skin. The effect may appear on a number of organs and systems of the human body (Robert *et al.*, 2001).

Any variation in minerals and the enzymes activity is an indication of the effect of the pollution. Therefore, this study is to evaluate the cement dust exposure and other pollutants in workers employed in different departments of cement factory by measuring potassium and sodium ions levels, blood urea, blood urea nitrogen and creatinine which may lead to know the effects on kidney's functions.

Materials and Methods

Specimen Collection and Serum Preparation

The blood specimen collected from 55 workers of different departments of Hamam AL-Alil Cement Factory and from students and employees of the University of Mosul as the control group. 4-5 ml of the drawn blood were put in plain tube, left to complete clot formation, the serum was then separated from the clotted blood by centrifugation at 3000 rpm for 15 min., then decanted into clean and sterile plain tubes and stored at (-20) C^o.

Estimation of Potassium and Sodium levels in Serum

Atomic absorption spectroscopy (AAS) technique was used to determine K and Na levels using the standard curve to convert the optical density into concentration (Zhang and Zhang, 2003).

Estimation of Blood Urea Activity and Blood Urea Nitrogen in Serum

The blood urea activity and blood urea nitrogen (BUN) was determined using a BIOLABO-Reagent/France kit (Tietz, 1999).

Estimation of Creatinine Activity in Serum

The serum creatinine was determined using a Biomaghreb/France kit (Henry, 1984).

Statistical Analysis

The statistical program (SPSS) was used to analyze the data (Indrayan and Sarkaddam, 2001).

Results and Discussion

K and Na levels :

The result showed that there was a significant decrease in potassium ion level in the serum of cement workers especially at Cement mill and Kiln departments (Table, 1). The result also indicated that there was a significant decrease in potassium ion with increasing exposure time to cement pollution (Table, 2).

The increase might be due to thallium is a mainly associated with potassium and rubidium, the source of thallium are gaseous emission of cement factories (EPA, 2006 ; HSDB, 1998). Also thallium and potassium ions have similar prosperities and on biological handling, both ions transverse cell membranes in similar way (Kazantzis, 1980). Or might be due to sulfur dioxides is observed by (Asha and Nirupma, 2004) who found a significant decrease in potassium level in the serum specimen of albino rats exposed to 120 ppm of sulfur dioxides after 4 weeks.

The results also showed a significant increase in sodium ion level in workers serum of all departments of the factory especially in Raw Mill and Kiln departments (Table, 1). A significant increase with increasing exposure time was also observed (Table, 2).

The increase might be due to the fact that potassium levels often change
with sodium level, when sodium level go up potassium level go down and reversed, or might be due to kidney disease or injury (Caroline, 2008).

Table1: K and Na levels in serum of cement workers depending on departments (mmol/L).

Departments	K	% Decrease	Na	% Increase
	Mean ± SE		Mean ± SE	
Control	5.02 ± 0.15 [b]	-	139.9 ± 1.54 [a]	-
Maintenance	3.92 ± 0.33 [a]	22.0	142.0 ± 4.97 [a]	1.5
Crusher	4.24 ± 0.19 [ab]	15.5	147.6 ± 2.60 [ab]	5.5
Raw mill	4.13 ± 0.20 [a]	17.7	163.3 ± 6.98 [bc]	16.7
Cement mill	3.90 ± 0.19 [a]	22.3	142.9 ± 1.82 [a]	2.1
Kiln	3.84 ± 0.21 [a]	23.5	166.9 ± 6.56 [c]	19.2
Packing	4.27 ± 0.23 [ab]	14.9	159.9 ± 5.01 [bc]	14.3

* Different letter vertically refers to presence of significant differences between treatment at $P \leq 0.05$, according to Duncan - test.

Table 2 : K and Na levels in serum of cement workers depending on exposure time (mmol/L).

Variables / Exposure time	K	% Decrease	Na	% Increase
	Mean ± SE		Mean ± SE	
Control	5.02 ± 0.15 [b]	-	139.9 ± 1.54 [a]	-
1 – 3	4.19 ± 0.14 [a]	16.5	151.2 ± 4.93 [b]	9.7
4 – 6	3.94 ± 0.13 [a]	21.5	155.8 ± 4.02 [b]	12.3
7 – 9 >	3.88 ± 0.22 [a]	22.7	157.5 ± 3.28 [b]	13.5

* Different letter vertically refers to presence of significant differences between treatment at $P \leq 0.05$, according to Duncan - test.

Blood urea and Creatinine:

The result indicated that there was a significant increase in blood urea in the serum of cement factory workers, the highest activity was in the Kiln and Crusher departments (Table, 3). The urea also increased with increasing exposure time (Table, 4).

The increase might be due to the tendency of urea enhancing protein catabolism together with accelerated amino acid deamination for gluconeogensis, on the other hand, the elevated levels of urea might be due to the destruction of red blood cells (Adamu and Audu, 2008 ; Calistus Jude *et al.,* 2002). And any malfunctioning in glomerular filtration results in the retention of substances including urea (Kamis *et al.,* 2003).

The results agree with publication of (Adamu and Kori-Siakpere, 2008) who found a significant increase in urea in serum, liver and kidney of the African catfish (*Clarias gariepinus*) when exposed to Portland cement powder in solution for 15 days.

Table 3 : Effect of cement pollution on blood urea and creatinine in serum of cement workers depending on departments (mg/100 ml).

Departments	Blood Urea	% Increase	Creatinine
	Mean ± SE		Mean ± SE
Control	22.7 ± 0.44 [a]	-	0.71 ± 0.01 [a]
Maintenance	27.0 ± 1.74 [ab]	18.9	0.71 ± 0.03 [a]
Crusher	32.4 ± 2.89 [b]	42.7	0.69 ± 0.06 [a]
Raw mill	26.5 ± 2.81 [ab]	16.7	0.72 ± 0.04 [a]
Cement mill	28.0 ± 2.67 [ab]	23.3	0.71 ± 0.03 [a]
Kiln	29.5 ± 3.08 [ab]	30.0	0.71 ± 0.04 [a]
Packing	24.0 ± 1.99 [ab]	5.7	0.69 ± 0.03 [a]

* Different letter vertically refers to presence of significant differences between treatment at $P \leq 0.05$, according to Duncan - test.

The result demonstrated that there was no effects on serum creatinine in cement workers (Table, 3). Also the results showed non significant decreased between creatinine and exposure time to cement pollution(Table, 4).

This might be due to that the decrease not occur in the first time of work and with respect to the slightly decrease with exposure might be due to that cement adversely interfered with the metabolism of creatinine leading to its observed reduction, an indication of partial loss of its functional capacity of tubular excretion (Zilva *et al.*, 1991).

Table 4 : Effect of cement pollution on blood urea, BUN and creatinine in serum of cement workers depending on exposure time (mg/100 ml).

Variables / Exposure time	Blood Urea	% Increase	Creatinine	% Decrease
	Mean ± SE		Mean ± SE	
Control	22.7 ± 0.44 [a]	-	0.71 ± 0.01 [a]	-
1 – 3	27.1 ± 3.69 [ab]	19.3	0.69 ± 0.04 [a]	2.8
4 – 6	28.7 ± 1.14 [b]	26.4	0.67 ± 0.03 [a]	5.6

7 – 9 >	30.7 ± 3.07 [b]	35.2	0.66 ± 0.02 [a]	7.0

* Different letter vertically refers to presence of significant differences between treatment at $P \leq 0.05$, according to Duncan - test.

BUN and BUN/Creatinine ratio:

The result in (Table, 5) showed that there was a significant increase in BUN in cement workers serum in all factory departments, the increase was proportional to exposure time (Table, 6).

The increase might be due to kidney or liver damage when exposure to thallium (Conerly and Blain, 2008). The results are in agreement with (Leung and Ooi, 2000 ; Fleck and Appenroth, 1996) who stated that the elevate of clinical chemistry parameters such as ALT, AST, BUN, blood glucose and sodium levels, indicating liver and kidney damage with thallium exposed.

Results also showed that there were increase in BUN/Creatinine ratio in workers serum of all cement factory departments (Table, 5), the highest in Kiln and Crusher. Also the increase was proportional with exposure time (Table, 6).

The increase might be due to the fact that ammonia formed from the oxidative deamination of amino acids is converted to urea by enzymes in the liver and then excreted in the urine by the kidneys, thus any change occurred in these enzymes (ALT, AST, LDH, ALP, …ect.) (AL-Hayali, 2009 ; Adamu and Iloba, 2008) may accelerate the delivery of amino acids to the liver which can enhance urea nitrogen formation and increase the BUN/Creatinine ratio (Brian and Robert, 1999).

Table 5 : Effect of cement pollution on BUN and creatinine ratio in serum of cement workers depending on departments.

Departments	**BUN (mg/100 ml)**	**% Increase**	**BUN/Creatinine**	**% Increase**
	Mean ± SE		**Ratio**	
Control	10.6 ± 0.20 [a]	-	14.9	-
Maintenance	12.6 ± 0.81 [ab]	18.8	17.7	18.7
Crusher	15.1 ± 1.36 [b]	42.4	21.8	46.3
Raw mill	12.3 ± 1.29 [ab]	16.0	17.0	14.1
Cement mill	13.1 ± 1.25 [ab]	23.5	18.4	23.4
Kiln	13.7 ± 1.44 [ab]	29.2	19.3	29.5
Packing	11.1 ± 0.92 [ab]	4.7	16.0	7.3

* Different letter vertically refers to presence of significant differences between treatment at P ≤ 0.05, according to Duncan - test.

Table 6 : Effect of cement pollution on BUN and creatinine ratio in serum of cement workers depending on exposure time.

Variables / Exposure time	BUN (mg/100 ml) Mean ± SE	% Increase	BUN/Creatinine Ratio	% Increase
Control	10.6 ± 0.20 [a]	-	14.9	-
1 – 3	12.6 ± 1.72 [ab]	18.8	18.2	22.1
4 – 6	13.1 ± 0.54 [b]	23.5	19.5	30.8
7 – 9 >	13.6 ± 1.28 [b]	28.3	20.6	38.2

* Different letter vertically refers to presence of significant differences between treatment at P ≤ 0.05, according to Duncan - test.

Conclusion

The changes may occurred in blood urea and creatinine can be considered suitable prognostic indicators of renal function in biomonitoring studies on workers exposed to occupational hazards.

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