Respiratory Symptoms, Pulmonary Function and The Role of Interlukin-1B in The Inflammatory Reaction among Workers at a Cement Factory in Cairo, Egypt

Sally A. Hakim[1], Nayera S. Mostafa[1], Mohamed Momen[1], Safaa M Abdel-Rahman[2]and Mona A. Abdel-Hamid[1]

[1]Department of Community, Environmental & Occupational Medicine, [2]Department of Medical Microbiology and Immunology Faculty of Medicine, Ain Shams University, Cairo, Egypt.

Received: January, 2016 Accepted: March, 2016

Abstract

Background: Cement workers are exposed to various workplace factors that may affect their health. These health effects depend on the duration, level of exposure and individual sensitivity. **Objective**: The aim of the study was to determine the effect of exposure to cement dust on lung function of workers in a national cement production factory at North Cairo and to identify the possible association between such findings and interlukin-1β in addition to personal and work-related factors. **Method**: It included 96 workers from different departments of cement factory (exposed group) and 100 workers group from an Egyptian public institution (control group). Data collected included personal data, occupational and medical history, clinical chest examination and body mass index. Pulmonary function tests were performed to suspected 60 subjects from the exposed group and all subjects from the control group. Interleukin-1β, liver function tests and kidney function tests were measured in 67 exposed workers who agree to provide a blood sample. **Results** showed that cement workers and controls were matched for age, gender and smoking status. Chronic cough and expectoration were significantly higher among the exposed group. Moreover, the percentage of cement workers with reduced FEV1, FVC was significantly higher than control group. The mean work duration of the exposed group was 24 years, small percentage of workers reported wearing personal protective devices as none reported they were informed about possible hazardous exposures before starting work. Most of the participants had normal interleukin levels and normal liver and kidney function tests. However, 8.8% of cement workers have elevated serum creatinine, 23.5% have elevated blood urea nitrogen, 13.2% have elevated serum ALT and 19.1% have elevated serum AST. The current study showed a significant higher proportion of cement workers with reduced FEV1/FVC among those working for ≥ 20 years duration compared to workers with those working for < 20 years duration.

Keywords: *Cement industry, pulmonary function, forced expiratory volume in the first second, forced vital capacity, interleukin*.

Corresponding author: Mohamed Momen e-mail :mmomen1977@gmail.com

Introduction

Cement industry represents a vital element in the economic development of countries and cement workers comprise an important productive sector in the community.[1,2]

In 2008, El-Sobky stated that workers in this industry are at risk of exposure to physical, chemical and mechanical factors which could have adverse influence on their health [(3)]. Cement can affect workers through the skin or eye contact or through inhalation. The risk of injury linked to the cement workers depends on the duration, the level of exposure and individual sensitivity.[4]

Cement dust causes irritation of the skin and mucous membrane of the eyes and respiratory tract. Its deposition in the respiratory tract causes a reaction in the form of increased pH values which irritates the exposed mucous membranes.[5]

It is difficult to determine the extent of work related illnesses because of the delayed period of most of the occupational diseases on cement workers. A significant percentage of all workers in cement industry are allergic to chromium resulting in mild skin rashes up to severe skin ulcers. Also, those workers have a higher prevalence of chronic cough, chronic bronchitis and chronic sinusitis.[6]

Cement particles are of a respirable size, so Portland cement is considered a potential cause of occupational lung diseases.[7] Each cement molecule is composed of 60-67% calcium oxide, 17-25% silicon oxide, 35% aluminum oxide, with some amount of iron oxide, chromium, potassium, sodium, Sulphur and magnesium oxide.[8] Aluminum, one of its components, could increase lipid peroxidation in tissues leading to neurotoxicity, renal failure and anemia[9], also chromium is a strong oxidizing agent with highly toxic effect on vital organs as lung, kidney and liver.[10]

Workers at a Portland cement factory usually complain of acute eye irritation and higher prevalence of respiratory symptoms and have reduced FVC, FEV1 and FEV1/FVC ratio among the workers with increased daily mortality.[11]

Many studies suggested that inflammation has an essential role in mediating pulmonary toxicity and fibrogenic effect of silica dust, as inhaled silica dust inflammatory process is characterized by recruitment and accumulation of neutrophils which secrete large quantities of pro-inflammatory cytokines. The pro-inflammatory cytokines as interleukin-1β (IL-1β) and tumor necrosis factor-α (TNF-α) target mainly the resident alveolar macrophage and activate the transcription factor nuclear factor-kappa B which is the main regulator for the pulmonary inflammatory responses.[12] Studies showed that IL-1β has a major role in particle-induced inflammation by enhancing granulocyte migration and accumulation to inflammatory sites.[13]

Major health problems in cement industry is related to dust exposure which is produced from different sections of the production process as the raw material crusher, rotary kiln, cranes, mills, storage silos and packing sections.[14] The final product contains calcium silicates, aluminates and aluminum ferrites.[15]

Cement dust causes chronic obstructive lung disease, restrictive lung disease, pneumoconiosis and cancer of the lung, stomach and colon. Moreover, this dust may enter the systemic circulation affecting other organs as the heart, liver, bone, spleen, muscles and hairs and can affect microstructure and physiological performance.[16,17]

Studies on the biomarkers of inflammatory response among cement workers are scarce and their conclusions are unclear [(18, 19)]. A study among Norwegian workers in a cement plant found an increase in the percentage of neutrophils and interleukin levels in induced sputum of exposed workers.[18] Other studies pointed to the effect of exposure to cement dust on the immune system.[20,21]

This study was carried out to determine the effect of exposure to cement dust on lung function of workers in a national cement production factory at North Cairo and to identify the possible association between such findings and interlukin-1β in addition to personal and work-related factors.

Methods

Study design and study setting: A cross sectional study was conducted between August 2017 to April 2018 among 96 male production workers from a national cement production company in the north of Cairo, Egypt (exposed group). The control group (100 workers) was of the same socio economic status and matched for age and gender but unexposed to cement dust.

The exposed group included workers from different departments of the factory: wrapping (60.4%), production (13.5%) and other sections as observation, concrete production and maintenance (26.1%).

Sample size estimation: A total number of 106 subjects was estimated using EpiCalc program version 1.02 assuming a power of 80% and alpha=0.05. The sample size calculation based on an estimated proportion of workers exposed to cement dust and developed respiratory symptoms of 45% and 20% among none exposed group.[14]

Study procedures: The cement workers included were those scheduled for periodic medical examination and the following services were done for them (a) Interview questionnaire including personal data as age, marital status, chronic diseases and smoking history, occupational data as job nature, work duration and symptoms related to occupational exposures. (b) Clinical chest examination by auscultation to identify any abnormality and suspected cases were further examined by undergoing pulmonary function test. (c) (60) Workers had pulmonary function tests done for them after clinical chest examination for general assessment and identification of their need for having this investigation. Forced expiratory volume in the first second, forced vital capacity, peak expiratory flow were measured using a portable spirometry (A23-053.06732 Spirolab III, MIR, Italy).The procedure for the ventilatory function test was explained individually to the participants, who were then given a practice test which was taken while standing. Three reproducible tracings were obtained and the best result was selected. (d) 67 workers agreed to take a blood sample from them to have a measurement of interleukin-1β (an inflammatory marker), liver function tests (AST, ALT), kidney function tests (serum creatinine, blood urea). Two ml of venous blood were collected under complete aseptic condition in sterile tubes. Samples were centrifuged, and sera collected and stored at -20C^{o}, till assay of serum IL-1β, liver function tests, and kidney function tests. Serum IL-1β was detected by ELISA (Assaypro LLC, USA) according to manufacturer instructions. (e) Measuring weight in kilograms and height in centimeters and using them to calculate the body mass index (BMI) by dividing the weight by the height squared in meter squared.

Data collected from the control group workers included personal, occupational and clinical data, in addition to chest examination, BMI and pulmonary function tests.

Ethical consideration was considered by assuring confidentiality of data and using anonymous questionnaires.

Statistical analysis was done using SPSS program (version 20). Descriptive statistics included mean, standard deviation, frequency and percentage for non-numerical data. Chi-square was used as test of significance with P-value less than 0.05 considered to be statistically significant.

Results

This study included 96 cement workers and 100 controls not exposed to cement and have been matched for gender and age. Also, there was no statistically significant difference between workers and controls as regards their smoking status. However, there was a higher percentage of married subjects and illiteracy among cement workers than controls (100% compared to 82% and 47.9% compared to 5% respectively; p<0.01). Additionally, there was a higher rate of obesity among control than cement workers (48% and 46.9 % respectively; P<0.05). Table (1)

This study has revealed a statistically significant higher prevalence of respiratory symptoms among cement workers compared to controls; chronic cough (21.9% compared to 6% respectively; p<0.01) and expectoration (24% compared to 4% respectively; p<0.01). At the same time, there was a statistically significant reduction of FEV1 and FVC among cement workers compared to controls (48.3% compared to 33% and 61.7% compared to 43% respectively; p<0.05). Table (2)

The mean work duration of the study group was 24 years, small percentage of workers reported wearing personal protective devices as none reported they were informed about possible hazardous exposures before starting work. Most of the participants had normal interleukin levels and normal liver and kidney function tests. However, 8.8% of cement workers have elevated serum creatinine, 23.5% have elevated blood urea nitrogen, 13.2% have elevated serum ALT and 19.1% have elevated serum AST. Table (3)

The current study showed also a statistically significant higher proportion of cement workers with reduced FEV1/FVC among those with work duration ≥ 20 years compared to workers with work duration < 20 years (72.7% compared to 27.3% respectively; p<0.05) Table (4)

Table 1: Socio-Demographic and Personal Characteristics of the Study Groups

Characteristic	Cement workers (N=96)		Control (N=100)		Total (N=196)		X^2	*p*
	N	%	N	%	N	%		
Age group								
< 40 years	24	25.0	32	32.0	56	28.6	1.18	0.343
≥ 40 years	72	75.0	68	68.0	140	71.4		
Age (mean ± SD)								
Marital status								
Single	0	0.0	18	18.0	18	9.2	19.03	0.001*
Married	96	100.0	82	82.0	178	90.8		
Education**								
Not educated	46	47.9	5	5.0	51	26.0	46.86	0.001*
Educated	50	52.1	95	95.0	145	74.0		
Smoking								
Smoker	45	46.9	42	42.0	87	44.4	0.47	0.57
Non-smoker	51	53.1	58	58.0	109	55.6		
BMI								
Normal	11	11.5	24	24.0	35	17.9	6.964	0.031*
Overweight	40	41.7	28	28.0	68	34.7		
Obese	45	46.9	48	48.0	93	47.4		

* Difference is significant at 0.01 level

**Uneducated includes those who cannot read or write and those who did not complete primary education.

Table 2: Respiratory Symptoms and Pulmonary Function Measurements of the Study Groups

Respiratory symptoms and measurements	Cement workers		Control		Total		X^2	p-value
	N	%	N	%	N	%		
Chronic cough	21	21.9	6	6.0	27	13.8	10.39	0.001**
Expectoration	23	24.0	4	4.0	27	13.8	16.426	0.001**
Chest tightness	21	21.9	20	20.0	41	20.9	0.104	0.441
Wheezes	13	13.5	24	24.0	37	18.9	3.498	0.050
Reduced FEV1	29	48.3	33	33.0	62	38.8	3.715	0.040*
Reduced FVC	37	61.7	43	43.0	80	50.0	5.227	0.033*
Reduced FEV1/FVC	11	18.3	17	17.0	28	17.5	0.046	0.495

Table (3): Occupational and laboratory data of the participating cement workers

variables	No. (%)
Work duration in years (mean ± SD)	24.34 ± 10.23
Wearing of personal protective devices:	
Workers who wear masks	30 (31.2)
Workers who wear gloves	23 (24)
Interleukin – 1β **levels:**	
Normal	50 (74.6)
elevated	17 (25.4)
Creatinine (mean ± SD) mg/dL	0.93 ± 0.29
Urea (mean ± SD) mg/dL	37.47 ± 15.54
ALT (mean ± SD) (IU/L)	29.90 ± 13.15
AST (mean ± SD) (IU/L)	29.34 ± 14.39
Interpretation of liver and kidney function tests:	
Elevated creatinine	6 (8.8)
Elevated urea	16 (23.5)
Elevated ALT	9 (13.2)
Elevated AST	13 (19.1)

Table 4: Association between Pulmonary Function Measurements and some Personal, Occupational and Lab Factors among Cement Workers

Factor	Reduced FEV1 N = 29	Reduced EVC N = 37	Reduced FEV1/FVC N =11
	n (%)	n (%)	n (%)
Age group			
< 40 years	8 (27.6)	9 (24.3)	1 (9.1)
≥ 40 years	21 (72.4)	28 (75.7)	10 (90.9)
	X^2 = 0.156 P=0.693	X^2 = 1.481 P =0.224	X^2 = 2.804 P =0.068
BMI			
Normal	3 (10.3)	6 (16.2)	0 (0)
Overweight	15 (51.7)	17 (45.9)	6 (54.5)
Obese	11 (37.9)	14 (37.8)	5 (45.5)
	X^2 = 0.434 P =0.805	X^2 =0.955 P =0.620	X^2 =2.135 P =0.344
Current smoking			
Non-smoker	18 (62.1)	22 (59.5)	6 (54.5)
Smoker	11 (37.9)	15 (40.5)	5 (45.5)
	X^2 = 3.270 P =0.071	X^2 =3.455 P =0.063	X^2 =0.111 P =0.739
Duration of employment			
< 20 years	15 (51.7)	20 (54.1)	3 (27.3)
≥ 20 years	14 (48.3)	17 (45.9)	8 (72.7)
	X^2 =0.243 P =0.622	X^2 =0.035 P =0.852	X^2 = 4.184 P =0.041*
Use of masks			
No	15 (51.7)	22 (59.5)	5 (45.5)
Yes	14 (48.3)	15 (40.5)	6 (54.5)
	X^2 = 1.009 P =0.433	X^2 = 0.050 P =0.822	X^2 =0.919 P =0.500
Interleukin level			
Normal	19 (65.5)	29 (78.4)	8 (72.7)
Elevated	10 (34.5)	8 (21.6)	3 (27.3)
	X^2 =1.735 P =0.185	X^2 =1.256 P =0.262	X^2 =0.003 P =0.614

* Difference is significant at 0.05 level

Discussion

The current study was conducted among 96 workers from different sections of a cement factory. Exposure to cement was expected to be nearly the same among all workers since they work in rotatory shifts among different sections of the industrial process. Generally, the working environmental conditions were poor. Most of the workers were uneducated and none of them received training courses about the expected occupational exposures that may encounter at work and methods of prevention. The current work showed that a significant difference was found in reporting chronic cough and expectoration which were higher among the exposed group. Moreover, the percentage of cement workers with reduced FEV1, FVC was significantly higher than the percentage of controls for these readings.

Regarding the respiratory symptoms, it was found in one study that the percentage of exposed workers to cement reporting recurrent and prolonged cough, phlegm, wheeze, dyspnea, bronchitis, sinusitis, shortness of breath and bronchial asthma was higher than the non-exposed. Moreover, those exposed workers suffered significantly lower ventilator function (VC, FVC, FEV1, FEV1/FVC and PEF). It was found also that the inhalation of cement dust causes irritation of the respiratory epithelium and smoking aggravates this effect.[22]

Occupational exposure to cement dust leads to a high prevalence of chronic respiratory symptoms and to decreased ventilator capacity.[23,24]

Yang et al results are in agreement of the current study findings where reductions in ventilatory function were found.[25] Another work among Egyptian cement workers where FEV1/FVC ratio was significantly lower for age groups 30 to 49 years old.[26]

Another work also recorded the most common respiratory symptoms were stuffy nose and shortness of breath. Moreover, a statistically significant post shift reduction in PEF, FEV1, FEV1/FVC was found in the exposed group.[27] Affection of lung function among cement factory workers was also studied by other researchers who found a cross-shift decrease in PEF, FEV1, FVC, FEV1/FVC.[18] A study among 4265 European cement factory workers showed a high prevalence of respiratory symptoms and decreased dynamic lung volumes among the exposed workers compared to the office staff.[28]

These findings differ from Abu Dhaise et al, 1997 who found that cement dust did not affect lung function in Jordan cement workers to a big extent.[29]

In the current study, 31% reported wearing masks and 24% wore gloves, in another work 40% wore masks.[27] This low percentage of workers wearing masks may be related to their feeling that masks do not provide adequate protection in reducing dust exposure. Moreover, none of our workers reported receiving pre-employment training or orientation.

Regarding serum interleukin -1β levels, it was found that 25.4% of participants had elevated levels (table 3). This indicates an inflammatory process in the lungs of those workers. Researchers also found that interleukin-1β correlates significantly with FEV1, which draws attention to its role in clinical aspects of the disease severity [30, 31]. Studies suggest that cement workers are at a greater risk of a systemic inflammatory state[17]: Cell markers, cytokines, and immune parameters in cement mason apprentices.

Drost et al., (2005) in their study and Cheng et al., 2008 (Cheng et al., 2008) in their work found a significant positive correlation between inflammatory cytokines and FEV1/FVC and FEV1 respectively.[32,33] It has been found that long term exposure to cement affects the levels of the pro inflammatory mediators as interleukin beta 1.[34] However, this was not the condition in the current work where no significant association was found between interleukin levels and lung volumes (Table 4).

The mean values for liver and kidney functions among the study subjects were in contrast to those of another study where blood urea was elevated among workers 37.47±15.54, creatinine 0.93±0.29, while for liver function ALT mean values were 29.90±13.15 which was lower than the mean findings for ALT in our work while for AST the mean values of their work was 29.34±14.39 which was similar to the current study results.[35]

No significant association was found between reduced lung volumes and age, body mass index, current smoking, use of masks and interleukin levels. A significant

association was found reduced FEV1/FVC ratio and work duration. (Table 4)

This is similar to the results of another work which showed that the duration of employment in some cement processing sections was associated with cross shift reduction in PEF. This may be a result of increased sensitivity of the airways related to long term exposure to cement or a result of hypersensitivity to specific components as chromium present in cement.[14] Our result differs from that of Fell et al (2003) where no duration response-related decline in lung function indices was found.

Body mass index was not significantly associated with pulmonary function tests in this study similar to the results of Falaschetti et al in 2004.[18,36]

Conflicts of interest: The authors of this study declare that they have no competing interests.

References

1. David, K, Kee-Seng, C and Jeyaratnam, J (2005):Textbook of occupational medicine practice, 2nd ed. Word Scientific Publisher Company; 307-308, 382.
2. Baskett, R (2007): Occupational Health Nursing: a theoretical model. AAOHN Journal; 40(10); 90-96
3. El-Sobky MK (2008): Study of accidents among workers Helwan cement factories. MD Thesis, Faculty of Medicine, Cairo University Egypt.
4. Saucier K and Janes S (2004): Essential of community based nursing ,1st ed; London: Jones and Publishers; 271-272.
5. Zuskin E.,Butkovic D.,Neilschachter E. and Mustajbegovic J (2007): Respiratory function in workers employed in the cement factories. American Journal of Industrial Medicine; 23(6); 835-844.
6. Mehraj SS, Bhat GA and Balkhi HM (2013): Cement factories and human health. Int. J. Cur. Res; 5(18): 47-53.
7. Gbadebo, AM and Bankole OD (2007): Analysis of potentially toxic metals in airborne cement dust around sagamu southwestern Nigeria . J.Applied Sci.; 7:3540.
8. Mohammad A and Abdollahi M (2011): A systemic review on oxidant /antioxidant imbalance in aluminium toxicity . Int. J. Pharmacol.; 7:12-21.
9. Adly AA (2010).Oxidative stress and disease . Res. J. Immunol.; 3:129-145.
10. 10. Samet JM, Dominici F, Zeger SL Schwartz J and Dockery DW (2000): The National Morbidity, Mortality, and Air Pollution Study. Health Effects Institute Research Report; 94
11. Wang HF, He FQ, Xu CJ, Li DM, Sun XJ et al (2017): Association between the interleukin 1 B C -511T polymorphism and periodontitis: a meta-analysis in the Chinese population. Genet Mol Res. PMID 28252166. Doi: 10.4238/gmr16019315.
12. Rabolli V, Badissi, AA, Devosse R, Uwambayinema F, Yousof YY et al (2014): The alarmin IL-1α is a master cytokine in acute lung inflammation induced by silica micro and nanoparticles. Particle and Fibre Toxicology;11:69
13. Zhou T, Rong Y, Liu Y, Zhou Y, Guo J et al (2012): Association Between Pro-inflammatory Responses of Respirable Silica Dust and Adverse Health Effects Among Dust-Exposed Workers. Journal of Occupational Environmental Medicine;54:459-65.6
14. Zeleke JK, Meon BE and Bratveit M (2010): Cement dust exposure and acute lung function: a cross shift study. BMC Pulmonary Medicine; 1471 (2466): 1-8.
15. Mwaiselage J, Moen B and Brateveit M (2005): Acute respiratory health effects among cement factory workers in Tanzania : an evaluation of a simple health surveillance tool. Int Arch Occup Environ Health; 79(1): 49-56.
16. Ujoh F, Ujoh FT (2014): Appraisal of social and health impact of a cement plant

at host communities in Yandev, Nigeria. Science Journal of Public Health; 2(4): 275-83. doi: 10.11648/j.sjph.20140204.15

17. Carlsten C, de Roos AJ, Kaufman JD, Checkoway H, Wener M,et al (2007): Cell markers, cytokines and immune parameters in cement mason apprentices. Arthritis Rheum; 57: 147-153.

18. Fell A.K., Thomassen T.R., Kristensen P., Egeland T. and Kongland J (2003): Respiratory Symptoms and Ventilatory Function in Workers Exposed to Portland Cement Dust. JOEM; 45:1008-1014

19. Fell AK, Sikkeland LI, Svendsen MV, Kongerud J (2010): Airway inflammation in cement production workers. Occup Environ Med.; 67: 395-400.

20. Omini OI and Akpogomeh BA (2007): The effect of Limestone, Crush Rock and Asbestos /cement dust particles on the Ventilatory function parameters of chronically exposed workers in Calabar municipality and Akampka Local Goverment Areas of Calabar ,Cross River State, Nigeria. Journal of Medical laboratory Sciences; 16:1-3

21. Mojimoniyi FBO, Merenu IA, Njoku CH and Ibrahim MTO (2007): Regression Formulae for Predicting Hematologic and Liver Functions from Years of Exposure to Cement Factory Workers in Sokoto, Nigeria. African Journal of Biomedical Research; 10: 235240

22. Lange NE, Sparrow D, Vokonas P, Litonjua AA (2012): Vitamin D deficiency, smoking and lung function in the normative aging study. Am J Respir. Crit. Care Med; 186: 616-62

23. Al-Neaimi YI, Gomes J and Lloyd OL (2001): Respiratory illnesses and ventilator function among workers at a cement factory in a rapidly developing country. Occup. Med.; 51(6): 367-373.

24. Ali BA, Ballal SG, Albar AA and Ahmad HO (1998): Post-shift changes in pulmonary function in cement factory in Eastern Saudi Arabia. Occup Med; 48: 519-522.

25. Yang CY, Huang CC, Chiu HF, Lan SJ, Ko YC (1996): Effects of occupational dust exposure on the respiratory health of Portland cement workers. J Toxicol Environ Health; 49: 581-588.

26. El Sewefy AZ, Awad S, Merwalli M (1970): Spirometric measurements in an Egyptian Portland cement workers. J Egyptian Med Assoc; 53: 179-86

27. Aminian O, Aslani M and Haghighi KS (2014): Cross-shift study of acute respiratory effects in cement production workers. Acta Medica Iranica; 52(2): 46-152.

28. Nordby KC, Fell AK, Noto H, Eduard W, Skogatad M. et al (2011): Exosure to thoracic dust, airway symptoms and lung function in cement production workers. Eur Repair J; 38: 1278-1286.

29. Abu Dhaise BA, Rabi AZ, Al Zwairy MA, El Hader AF, El Qaderi S (1997): Pulmonary manifestation in cement workers in Jordan. Int J Occup Med Environ Health ; 10: 417-28

30. Hammad DR, Elgazzar AG, Essawy TS, Abd El Sameie SA (2015): Evaluation of serum interleukin – 1 beta as an inflammatory marker in COPD patients. Egyptian Journal of chest diseases and tuberculosis; 64(2):347-352).

31. Sapey E, Ahmad A., Bayley D., Newbold P., Snell N., Rugman P., et al (2009): Imbalances between interleukin 1 and tumor necrosis factor agonists and antagonists in stable COPD. J. Clin. Immunol.; 29: 508-516.

32. Drost EM, Skwarski KM, Sauleda J, et al (2005): Oxidative stress and airway inflammation in severe exacerbations of COPD. Thorax; 60:293-300.

33. Cheng SL, Wang HC, Yu CJ, et al (2008): Increased expression of placenta growth factor in COPD. Thorax 2008; 63: 500-506.

34. Alaa A (2016): Effect of Exposure to Portland cement dust on the periodontal status and on the outcome of non-surgical periodontal therapy. Int J Health Sci (Qassim). 2016; 10(3): 339–352
35. Sameen AM (2013): 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.
36. Falaschetti E, Laiho J, Primatesta P, Purdon S (2004): Prediction equations for normal and low lung function from the Health Survey for England. Eur. Respir. J; 23(3): 456-63.