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SERUM LEVEL OF INTERLEUKIN-1BETA (IL-1β) AND SPIROMETRIC PARAMETERS AMONG CEMENT PRODUCTION WORKERS

By

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Abstract

Introduction: Cement production is a dusty operation with risk of exposure to cement particles during most stages of manufacturing process. Inhalation of cement dust irritates the mucous membranes of the respiratory system which is associated with increased level of serum Interleukin-1beta (IL-1β) and decreased respiratory function parameters. Workers in this field are at risk to occupational respiratory diseases as asthma, chronic bronchitis and silicosis. **Aim of work:** This study was carried out to determine the effect of cement dust exposure on the levels of IL-1β as an inflammatory marker and spirometric parameters among cement production workers. **Materials and methods:** Thirty three workers exposed to cement dust in their workplace participated in the study. A control group of 33 individuals were randomly selected to be matched with the exposed group as regards age, gender, and special habits of medical importance and not exposed to cement. Full medical history and clinical examination were carried out to all participants. Pulmonary function tests (FVC%, FEV1% and FEV1/FVC%) were measured and serum level of lL-1β was measured for both groups. **Results:** The study revealed that FVC%, FEV1% and FEV1/FVC% were decreased among the exposed group with a statistically significant difference for FEV1 and FEV1/FVC ($p<0.05$, $p<0.001$), but not for FVC% ($p>0.05$). The serum level of IL-1β was increased among the exposed group with a statistically significance difference ($p<0.001$). The duration of exposure to cement dust was negatively correlated with FVC%, FEV1% and FEV1/FVC% which was statistically significant for FEV1% and FEV1/FVC% but not for FVC%. There was a statistically significant positive correlation between the duration of exposure and the serum level of IL-1β among the exposed group ($p<0.05$). There were statistically significant negative correlations between the serum level of IL-1β among the exposed group and FVC%, FEV1% and FEV1/FVC%. **Conclusion:** Occupational

exposure to cement dust in the workplace is associated with decreased spirometric parameters and increased serum level of IL-1β.
Key words: Cement, Spirometric parameters, Interleukin-1beta and Airway inflammation.

Introduction

Cement industry is one of the largest manufacturing industries and its workers are exposed to dust at various manufacturing and production processes (Meo et al., 2013).

The production of cement is related to multistage processes that include quarrying, crushing, raw milling, blending, production of clinker, milling and packing. Cement workers are exposed to a variety of occupational hazards, one of the most important being dust exposure (Rachiotis et al., 2012).

Cement dust is a mixture of calcium oxide, silicon oxide, aluminum trioxide, ferric oxide, magnesium oxide, sand and other impurities. The aerodynamic diameter of cement dust particles is within the respirable extent; consequently occupational exposure to cement dust can cause numerous health hazards including the onset of acute or chronic respiratory diseases, and impairment of respiratory functions (Baby et al., 2008).

Studies have shown that adverse respiratory health effects were seen among people exposed to cement dust, an example is in increased frequency of respiratory symptoms and decreased ventilatory function which are most commonly observed among cement workers and could not be explained by age, Body Mass Index (BMI) or smoking, thus are likely to be caused by exposure to cement dust (Abdelhamid, 2016). It has been found that there is a significant positive correlation between BMI and FEV1/FVC in non-asthmatics and a significant negative correlation between BMI and FEV1 in obese patients, which is suggestive of the restrictive effect of increased BMI (Banerjee et al., 2014). Cigarette smoking causes deficits in both FEV1/FVC and FEF25-75, which indicate airway obstruction and small airway disease in adult smokers (Tantisuwat and Thaveeratitham, 2014).

Inhalation of cement dust irritates the mucous membrane of the

respiratory system. The cement dust stimulates inflammatory mechanism in the airway of the workers confirmed with significant increase in the level of airway neutrophils and interlukin-1 beta (IL-1β) in the sputum samples of the exposed workers, so workers in cement industry are at risk of developing occupational pulmonary diseases including asthma, chronic bronchitis or silicosis (Aminian et al., 2014).

Cement production workers are known to have significant silica exposure, and silicosis is thought to increase risk of autoimmune disease. These masons had higher levels of serum pro-inflammatory cytokines (serum IL-1β, IL-2 , IL-4 , IL-10, and interferon-gamma.),These preliminary findings suggest that cement masons may be at greater risk of a systemic inflammatory state that is potentially linked to immune dysregulation (Carlsten et al.,2007).

Aim of work

This study was carried out to determine the effect of cement dust exposure on the levels of IL-1β, as an inflammatory marker, and spirometric parameters among cement production workers.

Materials and methods

Study design: cross sectional comparative study.

Place and duration of study: the study was carried out in cement production factory in Sokhna during the period from May to November 2016.

Study sample: All workers who met the inclusion criteria and agreed to participate in the study were 33 males. Inclusion criteria for exposed group were exposure to cement dust during the production process. Exclusion criteria included the presence of any autoimmune diseases and exposure of other substances from other jobs outside the factory if any.

A control group of 33 individuals were randomly selected as to be matched with the exposed group as regards age, gender, and special habits of medical importance. They were patients coming to outpatient clinic at Kasralainy hospital. They all had no history to exposure to any type of dust and had no respiratory or autoimmune diseases.

Study methods:

- **History and clinical examination**

Full medical history was taken including personal, occupational, present, past and family history. Full clinical examination was carried out to the studied groups.

- **Laboratory Investigation**

A blood sample of 3 ml was drawn through venipuncture of the arm using sterile plastic syringe. Blood was centrifuged for separation of serum to determine the level of IL-1β by Enzyme Linked Immunosorbent Assay (ELISA) for all individuals (the exposed and control groups).

Interleukin- 1β is normally below the level of detection in the sera of healthy individuals, thus it is distinctive of a pathological situation or an inflammatory response (Goldbach-Mansky, 2012)

- **Pulmonary function tests**

Forced vital capacity (FVC), forced expiratory volume in the first second (FEV1) and FVC/FEV1 were measured during the shift using portable spirometry for the studied groups.

Consent

A verbal consent was obtained from subjects who agreed to participate in the study before the start of work; with assurance of confidentiality and anonymity of data.

Ethical approval

Approval of the administrative authority of the company was obtained. The study protocol was approved by the Ethical Committee of the Department of Occupational and Environmental Medicine, Faculty of Medicine, Cairo University.

Data management

Data were analyzed using SPSS 16. The mean values, standard deviation (SD) were estimated for quantitative variables. Shapiro-Wilk test was used to check the normality of distribution of data for all quantitative variables. Comparisons between the exposed and control groups were done using independent samples t- test for parametric data. Mann-Whitney test was used to compare between non-parametric data. Correlations (r) were done to detect the linear relations between quantitative variables. p values less than 0.05 ($p<0.05$) were considered statistically significant, and p values less than 0.01($p<0.01$) were considered highly statistically significant.

Results

Table (1): Some demographic characteristics of the exposed and control groups.

Items	Exposed group Mean± SD	Control group Mean± SD	Mann-Whitney	p value
Age (yrs)	39.24± 8.34	41.57±13.29	0.22	>0.05
Weight (Kg)	78.54±10.5	79.65±13.07	0.89	>0.05
Height (m)	1.59±27.4	1.67±13.32	1.7	>0.05
Smoking index#	1.53±28.27	1.66±37.57	0.53	>0.05

#Smoking Index= No. of cigarettes/day × duration in years.

Table 1 shows that there is no statistical significant difference (p>0.05) between the exposed and the control groups as regards age, weight, height, and smoking index.

Table (2): Comparison between the exposed and the control groups as regards some ventilatory pulmonary function tests.

Name of test	Exposed group Mean± SD	Control group Mean± SD	t	p value
FVC%	77.36±5.44	87.45±7.233	6.401	>0.05
FEV1%	64.87±10.1	82.39±18.39	4.7	**< 0.05***
FEV1/FVC	67.96±3.29	83.15±11.07	7.5	**< 0.001****

*: Statistically significant **: Highly statistically significant

Table 2 shows that there is mild restrictive impairment among the exposed group with no statistical significant difference (p>0.05) compared to the control group. Meanwhile, there is mild to moderate obstructive impairment among the exposed group with statistical significant difference (p<0.05, <0.001) compared to the control group.

Table (3): The level of Interlukin-1 beta (IL-1β) among exposed and control groups.

IL-1β	Exposed group (Mean±SD)	Control group (Mean±SD)	Mann-Whitney	p value
Pg/ml	5.58±4.2	0.56±0.402	6.98	**< 0.001

**: Highly statistically significant

Table 3 shows that the level of Interlukin-1 beta (IL-1β) is higher among the exposed group when compared to the control (highly statistically significant difference (p<0.001)

Table (4): Correlation coefficient between the duration of exposure to cement and measureable parameters.

Parameters	r	p value
FVC%	-0.300	> 0.05
FEV1%	-0.607	**< 0.001**
FEV1/FVC%	-0.498	**< 0.05***
IL-1 β	0.704	**< 0.001**

*: Statistically significant **: Highly statistically significant

Table 4 shows that there is a statistically significant negative correlation (p<0.001, <0.05) between the duration of exposure and (FEV1%, FEV1/FVC) and a statistically highly significant positive correlation (P<0.001) between the duration of exposure and the serum level of IL-1β.

Table (5) Correlation coefficient between the serum level of IL-1β and the parameters of ventilatory pulmonary function tests.

Parameters	r	p value
FVC%	-0.397	**< 0.05***
FEV1%	-0.332	**< 0.05***
FEV1/FVC%	-0.423	**< 0.001****

*: Statistically significant **: Highly statistically significant

Table 5 shows that there are negative correlations between the serum level of IL-1β and the percent of forced vital capacity (FVC %), the percent of forced expiratory volume in the first second (FEV1%), and the percent of FVC/FEV1 which are statistically significant ($p<0.05$, <0.001 respectively).

Discussion

Cement production workers are exposed to airborne particles of raw materials, clinker, and additives to the final cement product, and their work has been linked to changes in lung function and airway symptoms (Nordby et al., 2011). Cement dust exposure is associated with increased morbidity of airway diseases among exposed workers (Fell et al., 2010). We hypothesised that airway inflammation may be induced by cement aerosol exposure and would probably lead to detectable IL-1 β, as an inflammatory cytokine, in the serum of exposed workers.

The aim of the present study was to assess the respiratory functions together with serum IL-1β in cement production workers to detect airway inflammation.

The demographic characteristics of the study group (Table 1) showed that there was no statistically significant difference between the exposed and the control group as regards age, weight, height and smoking index ($p>0.05$). Meanwhile, comparison between the two groups as regards ventilatory functions parameters (Table 2) revealed statistically significant decreased FEV1% and FEV1/FVC among the exposed group compared to the control group ($p<0.05$ and $p<0.001$ respectively), indicating more prevalent

obstructive ventilatory impairment. On the other hand, FVC% showed mild decrease among the exposed group compared to the control group, which was statistically insignificant.

This was consistent with the results obtained by Nordby et al., 2011 who studied airway symptoms and lung functions among cement production workers. They found that FEV1% was more affected than FVC% and that there was an exposure–response relationship between exposure and reduced FEV1%. They concluded that dust exposure in the cement production industry may lead to obstructive lung function changes.

This was also in agreement with the results obtained by Mwaiselage et al., 2005 who studied respiratory symptoms and Chronic Obstructive Pulmonary Diseases (COPD) among cement factory workers. They found that cement workers seem to be at high risk of developing chronic respiratory symptoms and COPD, probably caused by cumulative total dust exposure independent of smoking habits.

On the other hand, our findings were partly not consistent with the results obtained by Kakooei et al., 2011 who studied dust exposure and respiratory health effects in cement production. They found that FVC in addition to FEV1 and FEF25-75% was significantly lower among exposed workers compared to control group. They concluded that exposure to the cumulative cement dust is associated with chronic ventilatory function impairment. This indicates that exposure to cement dust mainly affects FEV1% and FEV1/FVC, however, it may or may not affect FVC%.

As regards serum level of IL-1β in this study, it was higher among the exposed group compared to the control with a statistically highly difference ($p<0.001$) (Table 3). This was in agreement with the results obtained by Fell et al., 2010, who studied airway inflammation among cement production workers. They found a higher IL-1β concentration in the sputum of cement production workers during the exposed period compared with office workers and the external reference group.

This also agreed with the results obtained by Carlsten et al., 2007, who found that serum levels of IL-1β were elevated among American cement workers, whose major exposure is to cement aerosol.

The measured respiratory functions parameters among the exposed group of this study demonstrated a statistically significant negative correlation between the duration of exposure to cement dust at work and both FEV1 and FEV1/ FVC, while no correlation was found between duration of exposure to cement dust and FVC (Table 4). This may be explained by the results in Table 2 which demonstrate that obstructive airway diseases rather than restrictive were more common among the exposed group.

These results were consistent with those declared by Meo et al., 2013, who studied effect of duration of exposure to cement dust on respiratory functions of non-smoking cement mill workers. Their results showed that long term exposure (greater than 10 years) to cement dust prominently decreased the pulmonary functions among cement mill workers; they showed a significant reduction in FVC, FEV1, PEF and MVV relative to their matched controls.

In COPD, serum level of IL-1β correlates with clinical aspects of disease severity (Singh et al., 2010). In this study serum level of IL-1β positively correlated with duration of exposure to cement dust and this correlation was statistically significant (Table 4). It also showed a statistically significant negative correlation with respiratory functions parameters (Table 5). This indicates that serum IL-1β level elevation among the exposed group was part of airway inflammation and/or COPD. Taking into consideration that the exposed and control groups were matched as regards the smoking index (Table1), this airway inflammation among the exposed group with the corresponding elevated serum level of IL-1β can be attributed mainly to the exposure to cement dust at work.

This was similar to the results obtained by Hammad et al., 2015 who studied evaluation of serum interleukin-1 beta as an inflammatory marker in COPD patients. They found that the serum level of IL-1β was related to the stage of the disease as there was a significant increase in serum level of IL-1β with increasing severity of COPD. Very severe COPD cases have a higher level of IL-1β than severe and moderate cases. It was also raised in severe cases than moderate cases and the difference

between them was highly statistically significant ($p<0.01$).

Conclusion

Workers in cement production are at risk to develop inflammation of airways associated with increased serum level of interleukin-1beta (IL-1β) and decreased spirometric parameters (FVC%, FEV1%, and FVC/FEV1%).

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Conflict of interest

Authors declared that no conflict of interest exists.

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