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Assessment of respiratory health effects of cement dust on the workers of Rabak cement factory

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Abstract

Globally, the cement industry has been identified as a factor which causes significant pollution. This study is conducted to assess respiratory health effects of cement dust on the workers of Rabak cement factory, Sudan. This descriptive cross- sectional study was carried out at Rabak city. 134 samples were taken from the workers of the Rabak cement factory. The respiratory symptoms experienced, were scored and recorded using BMRC questionnaire on respiratory symptoms. The lung function measurements were performed using a portable Spirometer. The respiratory measurements of the subjects were Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1) and Forced Expiratory Volume ratio (FEV1%). The results of the study showed that: the majority of the cement workers were infected by allergy. Cement dust might be the main cause of respiratory infection in exposed subjects. The duration of exposure to cement dust affects the prevalence of respiratory diseases among the cement workers. The present study clearly revealed that cement dust is not only the major cause of environmental pollution in the study area but also a threat to health of local inhabitants in addition to the worker. It has also been observed that majority of workers do not use personal protective equipment.

Keywords: Respiratory health; Cement dust; Cement workers; Rabak; Sudan

1. Introduction

Air is the basic necessity of human life, but the quality of air is deteriorating continuously and it is being constantly polluted from different sources. One of the major sources of air pollution is cement industries (Mohammed Ali, 2015).

Cement industry represents one of the most important strategic industries and a basic element in the economic development of any country (Mansour, 2008). As well, their workers constitute an important productive sector of the community and consequently are the wealth and welfare of the nation (Hamdy, 2007). Those workers are exposed in their working environment continuously to either potential or actual hazards which have an impact on their health, whether by acute or serious adverse effects (Rom, 2008).

The ambient air quality measurement in the vicinity of Rabak cement factory, carried out during (2012 - 2013) in the study area, showed the concentrations of all air particulate samples in locations near the factory: Agricultural area, Elamara block No.2 and block No. 3, Rabak Elgadima and Elishlaag were significantly lower than the standards for air particulate as prescribed by the Threshold Limit Value (TLV) from the American Conference of Governmental Industrial Hygienists (ACGIH) guideline for the total dust 10 mg/m^3. The factory may be able to be attributed to condition of the prevailing wind during pumping, in terms of its direction either vertically that takes the dust up in the atmosphere or

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horizontally that may take the dust on the lower levels in the atmosphere to be monitored at the period of sampling taken (Mohammed Ali, 2015).

Excessive concentrations of dust in the workplace may reduce visibility, may cause unpleasant deposits in the eyes, ears, and nasal passages, and may cause injury to the skin or mucous membranes by chemical or mechanical-action (Central Pollution Control Board, 2007). The concentration of air particulates were found higher in areas around the cement factory. These are probably due to the distance from the factory and the prevailing wind direction effect in the study area. Tiwari *et al*, (2014) suggested that the total dust concentration reduces as one moves away from the facility. Nevertheless the concentrations of air particulates in the study area were lower than the standard level. This may be due to the meteorological condition effect at the period of sampling. This study is conducted to assess respiratory health effects of cement dust on the workers of Rabak cement factory, Rabak city, Sudan.

2. Material and methods

2.1. Study area

Rabak cement factory facilities occupy an area at a distance of 8.2 km from Rabak city, 300 km south of Khartoum, the capital of the Sudan, where the raw material for cement production is available.

2.2. Study population

Across- sectional study was carried out at Rabak cement factory. Samples included only the workers at Rabak cement factory.

2.3. Data collection technique and tools

Data were collection through questionnaires that included questions on anthropometric measurements, period of staying in their area, health impact of cement industry, types and symptoms of respiratory diseases and lung function parameter tests. The questionnaire was filled under close supervision to avoid conflicts by the selected subjects.

2.4. Respiratory system measurements

Using the British Medical Research Council's (BMRC) questionnaire on respiratory symptoms (1960), the lung function tests were performed using a Spirometer. The measurements of the subjects were force vital capacity (FVC), forced expiratory volume in one second (FEV1), and forced expiratory volume ratio (FEV1%), according to the method described by Miller *et al*., (2005) and Alagappan (2011). All respiratory function tests were carried out at a fixed time of the day to minimize the diurnal variations by well-trained assistants.

2.5. Data analysis and processing

Statistical analysis was carried out with the Statistical Package for Social Sciences (SPSS). Means and standard deviation (SD) were calculated. In addition to chi square and analysis of variance (ANOVA).

3. Results

The majority of cement workers (80.6%) works 8 hours in one shift, while 17.9% works between 8-12 hours, and less than 2% works more than 12 hours, as shown in Table (1).

Table 1 Numbers of hours in the shift of cement workers

Hours in the shift	Frequency	Percent
8 hours	108	80.6
8-12 hours	24	17.9
More than 12 hours	2	1.5
Total	134	100.0

The study found that cement industry has health effects on the workers. Also the results indicated that there were significant relations between cement industry, health impact and the suffering from the respiratory diseases in the workers (p- value < 0.05). The result also indicated that (92.9%) of the subjects suffered from respiratory infection, Allergy (90%) and (83.8%) of the workers was suffering from inflammation of throat as shown in table (2).

Table 2 Correlation between the impact of cement industry and infected subjects

Health impact	**Suffer from respiratory diseases**				**Total**	
	Yes		**No**			
	No	**%**	**No**	**%**	**No**	**%**
Allergy	9	90	1	10	10	7.5
Inflammation of throat	62	83.8	12	16.2	74	55.2
Respiratory infection	13	92.9	3	18.75	16	11.9
No impact	7	20.5	27	81,8	34	25.4
Total	91	67.9	43	32.1	134	100

Chi-Square = 53.887 df = 4 P- value = 0.000

The majority of the subjects (84.2%) answered that the emitted dust from the factory affected their health while (18.2%) of them did not affected by respiratory diseases as shown in Table (3). The result indicates that there was highly statistical significant difference between the emitted dust from the factory and the presence of respiratory diseases (p< 0.05).

Table 3 Correlation between emitted dust from the factory and presence of respiratory diseases in Rabak cement factory

Emitted dust	**Respiratory diseases**				**Total**	
	Yes		**No**			
	No	**%**	**No**	**%**	**No**	**%**
Yes	85	84.2	16	15.8	101	75.4
No	6	18.2	27	81.8	33	24.6
Total	91	67.8	43	32.1	134	100

Chi-Square = 49.683 df = 1 P. value = 0.000

Table 4 Correlation between types of infection and emitted dust in Rabak cement factory

Types of infection	**The emitted dust from the factory**				**Total**	
	Yes		**No**			
	No	**%**	**No**	**%**	**No**	**%**
Allergy	5	100	0	0	5	3.7
Inflammation of throat	5	83.3	1	16.7	6	4.5
Respiratory infection	49	96.1	2	6.1	51	38.1
Sore throat, respiratory infection	10	83.3	2	16.7	12	9
Asthma	16	94.1	1	5.9	17	12.7
No Infection	16	37.2	27	62.8	43	32.1
Total	101	75.4	33	24.6	134	100

Chi-Square = 50.985 df = 5 P. value = 0.000

The most common types of infection resulting from emitting dust were allergy (100%) respiratory infected (96.1%), inflammation of throat (83.3%), sore throat, respiratory infection (83.3%) as shown in Table (4). The results indicate that there was a high statistical significance between the types of infection and the emitted dust from the factory ($p< 0.05$).

The result indicates that there is a high statistical significant difference between the emitted dust from the factory and the presence of respiratory symptoms ($p < 0.05$) as shown in Table (5). The symptoms are as follows: Pains in chest (95.7%) dry cough or sneezing (95.2%) difficulty in breathing (93.9%) whizzing in the chest (90.9%).

Table 5 Correlation between emitted dust from the factory and symptoms of respiratory diseases

Symptoms	**Emitted dust from the factory**				**Total**	
	Yes		**No**			
	No	**%**	**No**	**%**	**No**	**%**
Difficulty in breathing	31	93.9	2	6.1	33	24.6
Pains in chest	22	95.7	1	4.3	23	17.2
Dry cough or sneeze	20	95.2	1	4.8	21	15.7
Whistling in the chest	10	90.9	1	9.1	11	8.2
No Symptoms	18	39.1	28	60.9	46	34.3
Total	101	75.4	33	24.6	134	100

Chi-Square = 49.670 df = 4 P. value = 0.000

The study found that ventilator lung function parameters FVC, FEV1 and FEV1% were significantly lower in the exposed group compared with a workers' group ($p<0.05$) as shown in table (6).

Table 6 Lung functions of exposed and workers' groups in Rabak City

Lung function parameters	**Exposed group**			**Workers group**			**P-value**
	Mean	**SD**	**No**	**Mean**	**SD**	**No**	
FVC	2.9097	0.73346	134	3.4055	0.76240	134	0.000
FEV1	2.5718	0.66898	134	3.0815	70034	134	0.000
FEV1%	87.4743	7.86181	134	89.9254	7.38483	134	0.010

FVC : force vital capacity; FEV1: force expiratory volume in one second

Most of the family members (65.6%) exposed to cement dust for a period of more than 20 years were infected with respiratory diseases more than the less exposed family (34.4%) as shown in Table (7). This indicates that the duration of exposure has effects on the prevalence of respiratory diseases. However, there was statistical significance between duration of exposure of family members infected by respiratory diseases ($p< 0.05$).

Table 7 Correlation between the family members infected by respiratory diseases and duration of exposure in the exposed group in Rabak city

Family members infected by respiratory diseases	**Duration of exposure (Year)**				**Total**	
	20 and less		**More than 20**			
	No	**%**	**No**	**%**	**No**	**%**
Yes	32	34.4	61	65.6	93	69.4
No	22	53.7	19	46.3	41	30.6
Total	54	40.3	80	59.7	134	100

Chi-Square = 4.383 df = 1 P. value = 0.036

The study found a statistical significant difference between duration of exposure to cement dust and lung function (FVC) the probability is equal (0.053). Whereas the result indicated that there was no significant difference between duration of exposure and lung function parameters (FEV1 and FEV %) as shown in Table (8).

Table 8 Lung function and duration of exposure to cement dust in Rabak city

Lung function measurements	Duration of exposure (year)	Statistics			
		N	Mean	SD	P .value
FEV1	20 and less	54	2.5896	0.645340	0.4850
	More than 20	80	2.5598	0.688240	
FVC	20 and less	54	2.9335	0.658760	0.0530
	More than 20	80	2.8936	0.783510	
FEV1%	20 and less	54	87.2139	6.83792	0.2470
	More than 20	80	87.6500	8.52116	

FVC : force vital capacity; FEV1: force expiratory volume in one second

The majority of responders (77.6%) were using personal protective equipment against dust as shown in Table (9).

Table 9 Use of personal protective equipment against dust

Use of personal protective equipment	Frequency	Percent
Yes	104	77.6
No	30	22.4
Total	134	100.0

4. Discussion

The majority of workers were affected by respiratory diseases such as allergy, inflammation of throat, respiratory infection. These results also agreed with (Dietz *et al*., 2004) who said that cement dust can cause various acute and chronic respiratory diseases. The prevalence of respiratory symptoms is higher among those exposed to cement dust when compared to those unexposed to cement dust. Moreover the presented results clearly showed a significant relationship between the emitted dust from the cement factory and the prevalence of respiratory diseases ($p < 0.05$). These results were consistent with the previous results obtained by Mwaiselage *et al*, (2006). They observed acute respiratory health effects among the workers which are most likely due to exposure to high concentrations of irritating cement dust. The results also highlight the usefulness of the questionnaire for health surveillance of the acute respiratory health effect.

According to the study finding, the researcher found a significant increased and correlation positively with dust emission and respiratory symptoms ($p < 0.05$). However the respiratory symptoms that are prevalent between cement workers in Rabak cement factory are: difficulty in breathing, chest pain, dry cough and sneezing. This result agrees with Laraqui *et al*, (2001) who reported that the exposure to the cement dust at workplace could result to chronic respiratory ailments in the form of cough, dyspnea, or chronic bronchitis on exposed workers. These findings raise a strong possibility that cement dust was the cause of wheezing and shortness of breath. Higher rates of bronchial asthma have been previously reported from other parts of the world, Abrons *et al*., (1997) reported a high rate of breathlessness among cement workers compared with blue collar workers. This study also conforms with the study by Chun *et al*., (1996) who said that occupational exposure to Portland cement dust may lead to a higher prevalence of chronic respiratory symptoms.

In this study it has been noted that there was an increase in respiratory symptoms during summer (47.8%) and winter (41.8%) because more cement dispersion occurred during these seasons.

The study found that duration of exposure to cement dust affects the prevalence of respiratory diseases among the population and cement workers. The population who are exposed for more than 20 years were more affected by respiratory diseases compared with populations exposed less than 20 years, the probability ($p < 0.05$). This result is confirmed by William and Ganong, (2005) the potential, chronic (long-term) health effects of particulate matter are, lung cancer, pulmonary emphysema bronchitis, asthma, and other respiratory infections. Moreover the study found long term exposure to cement dust prominently decreased the pulmonary function.

In this study a reduction in means of lung function parameters (FVC, FEV1, and FEV1%) has been observed on the cement workers in the study area, and this may be due to duration of exposure to cement dust. However the majority of the workers in the factory are employed for less than 20 years and the majority of them (80, 6%) work 8 hours per day, for that there was a limitation of exposure to cement dust. Shanshal and Al-Qazaz (2020) concluded that, Cement factory workers showed decreased lung function and abnormal spirometric patterns which we attribute to dust inhalation.

5. Conclusion

Significant differences were found between the accumulated gravimetric concentrations of cement dust and the prevalence rate of lung function (respiratory symptoms and ventilator function parameters) on the occupational workers (exposed workers) to cement dust.

Compliance with ethical standards

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Disclosure of conflict of interest

The author (Mazahir) declares no conflicts of interest regarding the publication of this paper.

Statement of ethical approval

The study was ethically cleared and endorsed by the Research Committee of the Institute for Environmental Studies, University of Khartoum. The cement factory manager also officially endorsed the study. All participants were informed about the aims of the study and his/her role as a participant, and then a verbal consent was taken. These formalities were done before launching the program of data collection.

Statement of informed consent

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