Evaluation of lung function in relation to employment years among workers exposed to cement dust in Qena cement factory

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Abstract

Background: Dust is generated by nearly all manufacturing steps within a Portland cement facility. Exposure to dust has the potential to impact respiratory function.

Objectives: The objective of this research was to evaluate the impact of the duration of exposure to cement dust on the pulmonary function of individuals employed in cement factories in Qena city, furthermore to assess the prevalence and distribution of respiratory impairment resulting from dust inhalation.

Patients and methods: A cross-sectional study, carried out on 100 cement industry workers in Qena who exposed to cement dust. They divided into 2 groups according to employment years in the factory (≤10 years and more than 10 years). Lung function tests including; [FEV1, FVC and FEV1/FVC] were measured.

Results: A significant reduction in the mean values of all the lung parameters among the workers employed more than 10 years compared with those employed ≤10 years. with p value (0.002, 0.014 and 0.000 considerably), there was a considerable variance between the 2 groups regarding all the spirometric pattern including [normal, obstructive and restrictive pattern] with p value (0.000 respectively). There is strong negative correlation between number of working years and FCV and FEV1.

Conclusion: The lung function of individuals employed in cement factories had shown to be declined, accompanied by atypical spirometric patterns in relation to prolonged exposure to cement dust.

Keywords: Cement dust; Working years, Spirometric parameters.

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Introduction

Occupational disease arises as a consequence of persistent exposure of individuals in the work place to deleterious occupational factors encompassing physical, chemical, biological, ergonomic, and psychological elements **(Clougherty et al., 2010)**. Environmental and occupational respiratory diseases constitute a substantial proportion of avertible illnesses **(Ross and Murray, 2004)**.

Cement is a highly prevalent construction material that is extensively utilized in various applications. Portland cement is composed of mineral dusts, which are released during the various stages of the cement producing process. Consequently, this leads to the exposure of workers to these dust particles. Cement dust is characterized by its high alkalinity and irritating properties, which may indicate a heightened potential for respiratory tract harm compared to other weakly soluble dusts **(Huntzinger and Eatmon, 2009).**

Previous studies have revealed that prolonged exposure to cement dust can result in a decline in lung function indices, namely forced expiratory volume in one second (FEV1), forced vital capacity (FVC) and forced expiratory volume/forced vital capacity (FEV1/FVC) **(Sulaiman et al., 2020).** This decline is attributed to the cumulative exposure to respirable cement dust and is accompanied by the occurrence of airway obstruction. Respiratory complications, which were observed in cement workers, were found to be correlated with alterations in chest radiography and pulmonary function **(Lippmann et al., 2015).**

Several clinical and epidemiological studies have shown an increased incidence of respiratory impairment and high frequency of respiratory symptoms among cement production workers **(Neghab and Choobineh, 2007).**

There are many literatures on the connection between cement dust exposure and changes in lung function, but the majority of it lacked a long-term examination of the duration-response relationship between years of exposure and lung function; therefore, we carried out this study to evaluate relationship between employment years and lung function among workers exposed to cement dust. The objective of this research was to evaluate the impact of the duration of exposure to cement dust on the pulmonary function of individuals employed in cement factories in Qena city. Additionally, this study aimed to establish the prevalence and distribution of respiratory impairment arising from the inhalation of cement dust.

Patients and methods

A cross-sectional study, carried out on 100 cement industry workers in Qena from production sections, from November 2022 to May 2023, the workers are classified into two groups according to employment years in the factory: group A: (≤10 years of employment) and group B: >10 years of employment.

Inclusion criteria

- Accept to participate in the study
- Employed for 3 years at least
- Exposed to cement dust

Exclusion criteria

- Not exposed to cement dust

- Smoker
- Any relevant or absolute cause for spirometry
- Any diagnosed acute or chronic chest disease.

The study was approved by the Local Ethics Committee of the South valley University, IRB: SVU-MED-COM009-4-23-8-708 and was conducted in accordance with the provisions of the Declaration of Helsinki.

Data collection techniques and tools

All participants were interviewed and each one of them provided informed verbal consent after explanation of the study for them. An interviewer administrated questionnaire is obtained from each participant including demographic data and spirometry was done according to the American Thoracic Society/European Respiratory Society guidelines **(Hankinson et al., 1999)**, using standard equipment; VIASYS Micro Medical Limited Po Box 6. Rochester; Kent ME 1 2AZ England. For each participant, the following pulmonary function parameters were assessed (FEV1), (FVC), and the ratio FEV1/FVC. Each participant received an explanation of the test method before doing spirometry. The classification of spirometric pattern was as follows: severe obstructive impairment was defined by a forced expiratory volume in one second to forced vital capacity ratio (FEV1/FVC) of less than 0.70 and a FEV1 less than 50% of the predicted value; moderate obstructive impairment was characterized by a FEV1/FVC ratio of less than 0.70 and a FEV1 ranging from 50% to less than 80% of the predicted value; mild obstructive impairment was indicated by a FEV1/FVC ratio of less than 0.70 and a FEV1 equal to or greater than 80% of the predicted value; and restrictive impairment was defined by a FEV1/FVC ratio of equal to or greater than 0.70 and a forced vital capacity (FVC) less than 80% of the predicted value **(Mannino et al., 2003 ; Ford et al., 2013).**

Statistical analysis

The statistical analyses were conducted using SPSS (Statistical Package for Social Science) software program version 26.0 (SPSS Inc., Chicago, IL). The quantitative parameters were compared using a student t-test after performing test of normality. Pearson's correlation analysis was conducted to examine the relationship between various variables. A p-value can be considered statistically significant when it is less than or equal to 0.05.

Results

A total of 100 male workers in production section in Qena cement factory with mean age of 40.9± 6.5 years divided into 2 groups group A working for ≤ 10 and group B working for > 10 with significant relationship between them regarding age (P value 0.000) and working years (P value 0.000) and body mass index BMI (P value 0.03) , but they have no difference regarding education or socioeconomic status (**Table.1**).

Table 1. Comparison of Socio-demographic features of the study population

Variables		All workers n=(100)	Working years		P value
			Group A (≤10 y) n= (50)	Group B (>10 y) n= (50)	
Age (mean± SD)		40.9±6.5	35.68±3.68	46.2±4.16	0.000*
BMI (mean± SD)		28.7±5.3	27.57±4.5	29.8±5.95	0.03*
Working years (mean± SD)		10.4 ± 4.6	6.7± 2.3	14.16±3.03	0.000*
Education N (%)	Illiterate	1(1%)	1(2.0%)	0	0.12
	Primary	11 (11%)	4 (8.0%)	7 (14.0%)	
	Post primary	63 (63%)	28 (56.0%)	35 (70.0%)	
	University	25 (25%)	17 (34.0%)	8 (16.0%)	
Socioeconomic status N (%)	Low	40 (40%)	20 (40.0%)	20 (40.0%)	0.6
	Moderate	59 (59%)	29 (58.0%)	30 (60.0%)	
	High	1 (1%)	1 (2.0%)	0	

*Independent-samples *t* test. **Chi-square test was used to compare proportions between groups. PV= P value. N (%)= number (percent)

Table (2) showed the comparison between the mean spirometric measures between the two studied groups where there was considerable variance between the 2 groups regarding all the mean values of the PFT including (FCV, FVC, FCV/FVC) with p value (0.002, 0.014 and 0.000 considerably).The comparison of the spirometric patterns between the two studied groups where there was a considerable variance between the 2 groups regarding all the spirometric pattern including [normal, obstructive and restrictive pattern] with p value (0.000 respectively).

Table 2. Comparison between the mean spirometric measures and patterns between the two studied group :

Variables		All workers n= (100)	Working years		P value
			Group A (≤10 y) n= (50)	Group B (>10 y) n= (50)	
Spirometric parameters (mean± SD)	**FCV**	2.99±1.04	3.5±0.69	2.4±1.02	0.002*
	FEV 1	2.42±0.8	2.8±0.57	1.99±0.77	0.014*
	FEV1/FVC	82.49±9.2	79.9±5.28	85.08±11.38	0.000*
Spirometric pattern N (%)	**Normal**	19 (19%)	19 (38.0%)	0 (0.0%)	0.000**
	Restrictive	78 (78%)	31 (62.0%)	47 (94.0%)	0.000**
	Obstructive	3 (3%)	0	3 (6.0%)	0.000**

*Independent-samples *t* test. **Chi-square test was used to compare proportions between groups. PV= P value. FEV_1, forced expiratory volume in first second FVC, forced vital capacity ;STD, standard deviation. N (%)= number (percent)

Table (3) illustrated that there is strong negative correlation between number of working years and FCV (r= -0.659, P=0.000). Furthermore, there is strong negative correlation between number of working years and FEV 1 (r= -0.638, P= 0.000). However, there is mild positive correlation between number of working years and percent (r= 0.385, P= 0.000).

Table 3.Correlation between the working years and the mean spirometric parameters of the study cohort:

		FCV	FEV 1	FEV1/FVC
Working years	r	-0.659**	-0.638**	0.385**
	P value	0.000*	0.000*	0.000*

FEV1, forced expiratory volume in first second; FVC, forced vital capacity. r=Pearson correlation coefficient. PV= P value.** Correlation is significant at the 0.01 level (2-tailed).

Table (4) illustrated the linear regression analysis between working years and spirometric parameters.

Table 4. Linear regression analysis between the working years and mean spirometric parameters:

Working years / Spirometric parameters	Beta	95.0% Confidence Interval		P value
		Lower Bound		
FCV	-0.659	-0.183	-0.115	0.000*
FEV 1	-0.638	-0.138	0.084	0.000*

FEV1, forced expiratory volume in first second; FVC, forced vital capacity.

Discussion

The current study revealed a significant association between exposure to cement dust and a decline in lung function, indicating that prolonged exposure to cement dust has a pronounced negative impact on pulmonary function. Workers in the cement mill industry who were exposed to the work environment for a period exceeding 10 years had a notable decline in [FVC, FEV1] in comparison to workers with an exposure time of less than 10 years.

In harmony with our study, several studies were conducted in numerous countries, including United Arab Emirates **(Abou-Taleb et al., 1995**), Saudi Arabia **(Ali et al., 1998),** Morocco **(Laraqui Hossini et al., 2002)** and Tanzania **(Mwaiselage et al., 2005),** where they proved that the decline in pulmonary function parameters, including forced vital capacity (FVC), forced expiratory volume in one second (FEV1), had a positive correlation with the length of time individuals were exposed to cement dust. Similarly, **Meo et al., (2013) found that** there was a decline in the lung function parameters [FVC and FEV1] with increasing duration of employment in the cement sector.

However, **fell et al., (2003)** summarized that there was no significant variance in the mean pulmonary function indices between cement mill workers and the control group. No change in pulmonary function indicators related to duration-response was seen**.** Nevertheless, they revealed a decrease in lung function indices as the duration of exposure to cement dust increased.

In this study we found that there is significant negative correlation between working years and FEV1 and FCV as lung function parameters decreased with increasing number of working years. The correlation between the decline in lung function and the duration of exposure to

cement dust was also seen and confirmed by **Milavdovic et al., 1991.**

We found that there was a significant variance in the prevalence of abnormal spirometric patterns (obstruction, restriction) between the 2 studied groups in relation to number of working years. In accordance, several studies approved that cement dust exposure causing abnormal lung patterns (**Shanshal & Al-Qazaz, 2021, Nasri etal., 2023** and **Khademi et al., 2019**).

The current study contributed further data to support the belief that cement dust has a detrimental impact on respiratory function, and this impairment was found to be correlated with the length of time individuals are exposed to cement dust. The significance of the findings lies in their ability to demonstrate the critical importance of minimizing the consequences associated with prolonged exposure. However, this study had several limitations including: First, the small sample size, second: it is a single center study, Third: the absence of a specific dust exposure assessment.

Conclusion

The lung function of individuals employed in cement factories was shown to be reduced, accompanied by atypical spirometric patterns. Hence, it is advisable to minimize prolonged exposure to cement industry, while ensuring that employees are granted a minimum of two official days of rest each week and a two-month annual leave.

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