Post-shift changes in pulmonary function in a cement factory in eastern Saudi Arabia

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This cross-sectional study was conducted in 1992 in the oldest of three Portland cement producing factories in Eastern Saudi Arabia. The respirable dust level was in excess of the recommended ACGIH level in all sections. Spirometry was done for 149 cement workers and 348 controls, using a Vitalograph® spirometer. FEV₁, FVC, FEV₁/FVC% and FEF₂₅-₇₅% were calculated and corrected to BTPS. A significantly higher post-shift reduction in FEV₁, FEV₁/FVC% and FEF₂₅-₇₅% was observed in the exposed subjects. Multiple regression analysis showed a significant relationship between post-shift changes and exposure to cement dust but failed to support any relationship with smoking. These findings may indicate an increase in the bronchial muscle tone leading to some degree of bronchoconstriction as a result of an irritant effect induced by the acute exposure to cement dust.

Key words: Bronchoconstriction; cement; lung function; post-shift; Saudi Arabia.

INTRODUCTION

The rate of industrialization in the Kingdom of Saudi Arabia has increased significantly over the past two decades. There is growing concern about the health hazards of such industrial technology and the need for implementing effective safety measures for the prevention of possible adverse health effects. The adverse effects on the lungs following exposure to cement dust have been studied worldwide with conflicting results. However, the acute effects remain relatively uninvestigated. The authors are not aware of any study that have examined the acute effect on the lung function following exposure to cement dust.

Currently there are a number of cement-producing factories in the Kingdom of Saudi Arabia (KSA). Three of these are in the Eastern Province. The current study was designed to determine the acute pulmonary effect of exposure to cement and assess the possible role of cigarette smoking on such an effect.

MATERIALS AND METHODS

The oldest of the three Portland cement factories in the Eastern Province of Saudi Arabia was selected for this cross-sectional study which was conducted in 1992. Using the payroll, 150 exposed employees were selected randomly from a total work force of 650, to represent the different production lines. Similarly, a total of 355 unexposed controls were selected randomly from among the administrative staff of this and other industries including ammonia, petrochemical and asbestos industries. All subjects were males since females do not work in industry in this country. All selected subjects completed a questionnaire regarding personal data and smoking habit. Respirable dust was measured using the gravimetric method. A total of 97 samples was collected from the quarry (29), raw mills (25), cement packaging (20), kilns (15) and eight from the cement mills. Pulmonary function was measured before and immediately after the morning shift using a dry bellows portable spirometer (Vitalograph® company). The morning measurements were not known to the investigators at the time of the evening measurements. The instrument was calibrated before starting the tests. The measured pulmonary function indices (PF1) were FEV₁, FVC and FEF₂₅-₇₅%. The index FEV₁/FVC% was subsequently computed. The height (in cm) without shoes and weight...
RESULTS

The mean (± SE) of age of the exposed was 38.0 ± 0.80 years compared with 34.3 ± 0.46 for the controls (p < 0.0005). The means (± SE) of the duration of service for the exposed and control subjects were 11.4 ± 0.6 and 6.1 ± 0.3 years, respectively (p < 0.0005). The exposed group belonged to the following ethnic origins: Arabs (56%), Indian-subcontinent (34%) and South East Asians (10%). The corresponding figures for the controls were 67.6%, 22.5% and 9.0%.

The concentration of respirable dust in the different working areas is shown in Table 1. The geometric mean (GM) in all areas exceeded the recommended threshold level of 5 mg/m³. The dustiest area was the quarry (GM ± SD = 20.28 ± 1.32 mg/m³ of air) and to a lesser degree the raw mills (GM ± SD = 15.21 ± 1.71 mg/m³ of air).

The smoking habit of the studied samples is shown in Table 2. There was no statistically significant difference between the two groups.

One of the 150 exposed (0.7%) and seven of the controls (2.0%) failed to perform spirometry satisfactorily. Significantly higher cross-shift reduction in the exposed workers was noted in FEV₁ (p = 0.0001), FEV₁/FVC% (p = 0.0001) and FEF₂⁰⁻₇⁵% (p = 0.001) but not in FVC (Table 3). Table 4 depicts the results of the multiple regression analysis. Only exposure to cement dust and the morning value of the PFI had a significant influence on the post-shift values of FEV₁, FEV₁/FVC%. These two predictor variables, in addition to age, were also significantly related to the post-changes in FEF₂⁰⁻₇⁵%. In regard to the FVC, it was only the morning value that was statistically significant.

DISCUSSION

To the best of our knowledge this is the first study that has examined the acute effect of inhalable cement dust on lung function and its interaction with smoking. The respirable dust level in all working areas exceeded the recommended threshold level of 5 mg/m³, which calls for immediate measures to reduce this level. The association between COPD and occupational dust exposure has been reported. Kalac in addition found evidence of obstructive peripheral airway disease in cement exposed employees.

The results also showed a significantly higher post-shift reduction in FEV₁, FEV₁/FVC% and FEF₂⁰⁻₇⁵% in exposed employees. Based on the results of the multiple regression analysis it was the exposure to cement dust and the initial pre-shift value of PFI rather than smoking that...
were responsible for such a significant post-shift change. On the other hand, the duration of service seems unlikely to contribute to such an effect. These findings may indicate an increase in bronchial muscle tone as a result of an irritating effect induced by the acute exposure to cement dust. Although we do not have information on the turnover of workers, the lengthy mean duration of service of the exposed group makes the finding less likely to be due to the healthy worker effect.

A study addressing the relationship of cross-shift changes to respiratory symptoms and the atopic status of the individual might be of interest and will add more to the understanding of the mechanism of the acute effect of cement dust on the lung function.

In conclusion, an immediate irritating effect on the respiratory tract leading to some degree of bronchoconstriction may be induced by exposure to cement dust.

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