Ergonomic Investigation of Respiratory Health among Grinding Workers of Indian Small and Medium (SMEs) Manufacturing Industry

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Abstract

The aim of this paper is to investigate the association of age and duration of work experience with pulmonary functioning of grinding workers in small and medium (SMEs) manufacturing industry of Jalandhar district of Punjab, India. A total of 61 workers participated in the study with a mean (SD) age of 35.91 (10.52) years and mean (SD) work experience of 11.01 (8.05) years. The standardized American Thoracic Society (ATS) respiratory questionnaire was used to obtain data for respiratory symptoms, and lung functioning was assessed by performing spirometry by each worker. Regression analysis was performed to find the effect of age and work experience over lung functioning of the grinding workers. Chi-square test was performed to find the association between age and lung functioning, and work experience and lung functioning. A significant effect (p<0.05) of work experience and age over lung functioning was found among grinding workers. It is concluded that age and duration of exposure are the contributing factors in decline of respiratory health among grinding workers.

Keywords: Grinding workers, Respiratory symptoms, Lung functioning, ATS questionnaire, Spirometry, SMEs

Introduction

The manufacturing industry is associated with processing of raw material into finished products. The various processes are involved in production of finished product. The grinding process is one of the major processes of production in a manufacturing industry. Consequently, a large amount of labor is involved in grinding work. Industrial workers are facing respiratory health problem in various countries. Pham et al. conducted a 5-year longitudinal study between exposed and unexposed steel industry workers and reported a decline in lung functioning of the workers. Dust exposure is associated with decline in spirometric parameters, i.e., forced vital capacity (FVC), forced expiratory volume in first second (FEV1), and percentage FEV1/FVC. A study has reported association of variables like age, smoking, socioeconomic condition, weight, with lung functioning. Jie et al. carried out a comparative study among dust-exposed grinding workers and unexposed control group found a significant decrease in FVC, FEV1, FEV1/FVC percentage, MMEF, VC of exposed group and revealed that long term exposure to grinding dust can develop changes in pulmonary function indices. Chen et al. conducted a study among steel workers of Taiwan and reported symptoms of chronic and frequent cough, chronic and frequent phlegm, breathlessness and occasionally wheezing and these symptoms were in relation with duration of work experience, smoking habits, level of dust and respiratory health in the past.
Gomes et al. conducted a study to compare respiratory functioning of dust on iron foundry workers and unexposed bottling company workers as a control group. They reported significantly lower values of FEF25-75, FEV1, PEF, FEV1/FVC, and FEV1/VC among exposed workers.7

Several studies have been conducted in developing countries to investigate the respiratory health of industrial workers.7-9 However, to our knowledge hardly any study exists in literature, related to respiratory health of grinding workers of Indian small and medium manufacturing industry. The present study investigates prevalence of respiratory symptoms and lung functioning of grinding workers. Further, the effect of age and duration of work experience over respiratory health of the workers is investigated.

Materials and Methods

The convenience based sampling method was used for the study from the grinding sections of manufacturing industries in Jalandhar district of Punjab state, India. A total of 61 male workers participated in the study. Age range of workers was 19–58 years with mean 35.91 (10.52) years and experience range from 1–28 years mean (SD) work experience of 11.01 (8.05) years.

Data was collected through the American Thoracic Society (ATS) questionnaire for respiratory symptoms, i.e., cough, phlegm, breathlessness, wheezing and chest colds and chest illness. The questionnaires were completed by interviewing the subjects in the industry. Demographic data of the workers including age and work experience was also recorded in the questionnaire. Each worker performed spirometric test using a portable spirometer and the values for forced vital capacity (FVC), forced expiratory volume in one second (FEV1), and ratio between forced expiratory volume in one second and forced vital capacity (FEV1/FVC) were recorded.

Percentage and frequency of respiratory symptoms was evaluated for each worker. The workers were categorized into normal and abnormal lung functioning according to the test results given by spirometry. Normal lung function defined as values of FVC>80% predicted, FEV1>80% predicted and FEV1/FVC>70% predicted. Abnormal lung functioning is defined as any value below normal value among FVC, FEV1, and FEV1/FVC.

Data Analysis

Data was analyzed using SPSS.20. Using independent samples T-test, the means of FEV1, FVC and FEV1/FVC were compared among workers with normal and abnormal lung functioning. Linear regression analysis was performed between age and FVC and FEV1; and then between work experience and FVC and FEV1. Chi-square test was performed to find the association between lung functioning and age and work experience. For applying the Chi-square test, age and experience were categorized into dichotomous as below and above mean of age, i.e., 35 and experience, i.e., 11 respectively.

Results

Questionnaire results reported that 43 (70.5%) and 44 (72%) workers had usually cough and phlegm respectively. 37 (60%) coughed 4 to 6 times a day, 4 or more days a week, whereas 34 (57%) brought up phlegm twice a day, 4 days out of the week. 34 (55%) of them reported cough at all rest of the day or night 21 (34%) reported this type of phlegm. 31 (50%) of workers reported cough for 3 consecutive months in a year, for more than consecutive 2 years. However, 28 (46%) reported phlegm for 3 consecutive months a year, for more than two consecutive years. 22 (36%) workers reported shortness of breath (SOB) grade 1, 17 (28%) reported SOB grade 2, 19 (31%) reported SOB grade 3, and 3 (5%) reported SOB grade 4. Wheezing with cold was reported by 49 (80%) and wheezing apart from cold was reported by 21 (34%), wheezing for most days or nights was reported by 16 (26%) and this wheezing for more than 2 consecutive years was reported by 23 (38%) workers. 43 (70%) workers reported chest illness, when they got cold, 25 (41%) workers had chest illness that kept them off work or in bed during the last 3 years. 30 (49%) produced phlegm with these chest illnesses. 31 workers reported one or more chest illness that kept them off work for a week or more.

The results of spirometry show 23 (37.7%) workers to be with normal lung functioning and 38 (62.3%) with abnormal (including mild, moderate or severe obstruction and restriction and mixed obstructive and restrictive patterns) lung functioning.

Independent sample T-test gives a statistically significant (p<0.001) result between the means of FEV1, FVC and FEV1/FVC with respect to normal and abnormal lung functioning (Table 1). Means of spirometric values were significantly lower in abnormal workers. Mean (SD) for FVC was 96.26 (10.87) and 75.36 (15.37), for FEV1 was 100.47 (11.08) and 71.44 (13.04) and for FEV1/FVC was 105.13 (6.32) and 95.94 (12.77) in normal and abnormal lung functioning of workers respectively.
Linear regression was conducted to investigate the effect of age in predicting FVC and FEV1. The results were statistically significant for FVC, $F(1,59)=16.03$, $p<0.05$ and FEV1, $F(1,59)=25.24$, $p<0.05$. The equation given by linear equation to find the effect of age on FVC equals $110.25+(-0.752)\times$ (age of the worker). The adjusted $R$ square value was 0.200, i.e., 20% of variance in FVC is explained by age of the worker. The equation of FEV1 was given by $117.27+(-0.974)\times$ (age of the worker) and variance explained was 28.8% which is a large effect.

In the second model of regression analysis, it was found that duration of work experience has a significant effect on FVC and FEV1. The effect of duration of work experience on FVC was given by $F(1,59)=10.82$, $p<0.05$. The regression equation for FVC is $92.46+(-0.838)\times$ (duration of work experience). The variance explained by age in predicting FVC was 14.1%.

Association of age and experience with lung functioning was significant as given by Chi-square test. The Chi-square values for age and experience with respect to lung functioning were given by $\chi^2=11.12; p<0.05$ and $\chi^2=5.83; p<0.05$ respectively.

**Discussion**

The present study has found the prevalence of respiratory symptoms among grinding workers. A number of studies had been conducted in different places which found the prevalence of respiratory symptoms among manufacturing industrial workers. A significant difference in means of FVC and FEV1 is found among normal and abnormal lung functioning of workers. This finding is in agreement with a previous study conducted by Rafeemanesh et al. among agate grinding workers. They found significant differences in FVC, FEV1, FEV1/FVC between workers with respiratory morbidity and without respiratory morbidity.

Significant association was found between FVC, FEV1, and age and duration of work experience. This trend is also shown earlier in literature. Nurul et al. conducted a study among Malaysian steel workers; they adopted spirometric testing and questionnaire in their study design.

They found the prevalence of respiratory symptoms of morning cough and phlegm, shortness of breath and chest tightness. Respiratory symptoms were significantly (p<0.05 and p<0.001) associated with age and duration of employment of the workers respectively. Multivariate analysis was conducted to find the effect of age, smoking habits and duration of work over FVC and FEV1. Age showed a significant effect on FVC, FEV1 and FEV1/FVC and duration of work was significant only for FVC and FEV1. Chen et al. also claimed that age is an important determinant of lung functioning indices. Pham et al. and Wang et al. also showed the effect of age on lung functioning.

**Conclusion**

From the findings of this study, it can be concluded that decline in lung functioning of the grinding workers is associated with age and duration of exposure. It is suggested that proper ventilation systems should be installed and workplaces should be revamped so that health risk to workers can be reduced.

**References**


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