RESEARCH ARTICLE

SILICOSIS – A MAJOR OCCUPATIONAL THREAT

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ABSTRACT
One of the most hazardous diseases associated with the construction industry is silicosis, which is the outcome of dust inhalation. The prolonged breathing of silica (quartz) or silicon dioxide is considered as a potent irritant that causes the occurrence of this disease. The respiration of silica leads to the formation of scar tissue inside the lungs which diminishes the ability of lung to extract oxygen from air and hence leads towards the pulmonary fibrosis condition. In the present study, the workers engaged in bricks and tiles operation were examined and their percentage cell damage has been determined. According to the statistical analysis performed, there is no significant difference between the cell damage of the workers either employed in bricks or tiles operation and thus they are equally affected by the inhalation of silica. In addition, it has been found that there is a weak correlation between the length of the service of individual worker and the cell damage which signifies that intensity of silica exposure varies and is poorly correlated with the duration of work. However, when compared separately, the workers in both operations depict some interesting and surprising correlations.

Keywords: Silicosis, silica, cell damage.

1. INTRODUCTION
One of the fundamental bits of earth’s crust is silica or silicon dioxide which is considered as an important component of dust. Silica has been demonstrated to be generated as a result of various construction operations such as, cutting, drilling, chipping, crushing or mixing1. The continuous exposure and inhalation of silica leads to silicosis which has been known as a vital occupational disease worldwide. Although diverse strategies have been taken into account to prevent silicosis but still it is a major occupational threat2. The disorder can be encountered anywhere in any country but is primarily prevalent in under developed countries because of limited resources and poor surveillance. However, according to a statistical analysis by Kauppinen et al.3 silicosis has also been regarded an occupational health concern in UK as during the period of three years from 1990 to 1993, 600,000 workers in UK and more than 3 million in Europe were exposed to crystalline silica. In between 1996 and 2009, less than 100 cases were reported every year in UK and the mortality rate has been reduced from 28 in 1993 to 10 in 20082,3.

Silicosis is characterized as a fibrotic pulmonary disease likely to be fatal in long term exposure. The disorder is the outcome of inhalation of large amounts of silica over time4. The worker usually remains asymptomatic with no physiological abnormality. However, in some complicated cases, it may be associated with cough, shortness of breath, sputum production and chest wheezing5. The uninterrupted inhalation of silica initiates an inflammatory response that leads to the development of a scar (fibrotic) tissue inside the lungs, which diminishes the ability of lungs to acquire oxygen from air. The lungs give the nodular appearance because of repeated cycles of regeneration of lung tissues and the histology reveals the deposition of collagen4,6.

The smoking being the risk factor for the predisposition of silicosis is still unclear. Several studies have been conducted to study the
association of smoking and silicosis. In a review, Hessel et al. described about 13 studies, out of which only 3 supported the hypothesis that smoking is directly associated with the incidence of silicosis. However, 8 provided the insignificant results, 1 did not support the hypothesis and the only study showed the inverse relationship between the two factors. The occurrence of silicosis is usually accompanied by various co-morbidities such as tuberculosis, lung cancer and auto-immune disease. To date, no effective treatment regimen has been introduced for silicosis and none have proved to reduce the mortality rate.

The purpose of the present study is to evaluate the difference between the cell damage of the workers employed in bricks and tile operations and to study the association of the length of service of the workers in both operations.

2. MATERIALS AND METHODS
2.1. Selection of Study Site and Subjects
A study was conducted on the workers employed from 1 year to 34 years in bricks and tile industries. In total, 65 workers were randomly selected, out of which 38 were engaged in brick operations and 27 were performing duties in the tile sector. However, smokers were excluded from this study.

2.2. Sample Collection
The blood samples of the workers from both bricks and tile exposure were collected for the analysis of lactate dehydrogenase (LDH) to determine the cell damage.

2.3. Statistical Analysis
The data was processed and presented statistically using Minitab statistical software (version 17). A significance criterion of probability value of $p < 0.05$ was used. As the data was not normally distributed so the non-parametric Mann Whitney test was used to evaluate the difference between the cell damage of the workers employed in bricks and tile operations. The null hypothesis in this case was: there is no significant difference between the two variables. However, the alternative hypothesis was: there is a significant difference between the two variables.

To assess the relationship between the length of service and cell damage of the workers, the data was analyzed using Pearson’s correlation test and correlation coefficient and $p$-values were interpreted. The null hypothesis in this case was: there is no significant association between the two variables. However, the alternative hypothesis was: there is a significant association between the two variables.

3. RESULTS
Normality test was performed to determine the normal distribution of the population in case of bricks workers (Fig. 1). A $p$-value of 0.019 was calculated, which is less than the significant value, thus the null hypothesis is rejected and the alternative hypothesis that the data do not follow a normal distribution and comes from a random population was accepted. This information allowed us to perform a non-parametric Mann Whitney test. Similarly, in case of data obtained from tile workers, the $p$-value of <0.005, which is lower than the significant value was calculated. Therefore, the null hypothesis was rejected and the alternative hypothesis that the
The analysis of relationship between the length of service and the cell damage was performed and $p$-value of 0.001 was calculated, which is lower than the significant value of 0.05. Hence, we rejected the null hypothesis and accepted the alternative hypothesis that there is a significant association between the two variables. However, the correlation coefficient value was 0.414 which shows a weak correlation between the two variables. After plotting a scatter plot (Fig. 3) between length of service and damaged cells, a poor correlation between the two variables have been observed.

However, interesting statistical results were obtained when the data was un-stacked separately into bricks and tiles. In case of bricks, the $p$-value of 0.123 which is greater than the significant value was calculated and hence we failed to reject the null hypothesis that there is no significant association between the two variables. The correlation coefficient value is 0.255 and scatter plot (Fig. 4) shows no trend between the two variables. In case of tiles, the $p$-value is 0.000 which is lower than the significant value and thus we reject

**Fig. 2.** Probability plot between percent damaged cells in tiles workers.

**Fig. 3.** Scatter plot of length of service and percent damaged cells.

**Fig. 4.** Scatter plot of length of service (bricks) and percent damaged cells (bricks).
between the cell damage of the workers performing their functions in bricks and tile operations. The exposure of silica and the extent of cell damage in workers employed in bricks sector are affected in a similar way as those in tiles sector. In addition, the individual’s length of service has a weak association in the extent of cell damage but when compared separately, the workers working in bricks show no correlation between their duration of service and cell damage. However, the tile workers showed a significant association. It may be due to the difference in sample size or other confounding variables.

The lactate dehydrogenase enzyme (LDH) is found to be a potent indicator to monitor the disease activity. All major biochemical organs of the body are well equipped with a cytoplasmic enzyme (LDH) that functions to unmask the cell damage or necrosis and is abnormally elevated in the individual with corresponding disorder. The level of LDH is raised after the incidence of silica inhalation⁹.

However, there are many other quantitative measures proposed in several investigational studies to determine the silicosis. The prolonged exposure of silicosis results into pulmonary fibrosis and the extent of exposure is not particularly governed by the measurement of LDH. The generation of reactive oxygen/nitrogen species in long term consequence of silica exposure initiates the fibrotic response and hence elevated level of these will be a good indicator¹⁰. In addition, quantitative measurements of pulmonary parenchymal disease using mean attenuation values have stimulated considerable interest including a chest radiograph. Bergin et al.¹¹ proved a significant correlation between the mean attenuation values and the international labor organization (ILO) profusion category which demonstrated a good indicator for the assessment of silicosis.

There were certain limitations in the data provided

In addition, to determine the association between age of the workers and cell damage, a $p$-value of 0.050 is found which is equivalent to the significant value and in that case we fail to reject the null hypothesis that there is no significant association between the two variables. Moreover, the correlation coefficient value was 0.244 which indicates very weak correlation between the two variables but it cannot be supported since the $p$-value is equivalent to the significant value and null hypothesis cannot be rejected in any way. In addition, the scatter plot (Fig. 6) does not show any trend and association between the two variables.

4. DISCUSSION
This study demonstrates that there is no difference
in this study. In each industry, a standard medical record form of each employ has already been maintained. The previous silica exposure of each individual was not mentioned as it is important to study the silica load burden.\textsuperscript{12} Moreover, the working hours of the employees were not provided along with the exposure to other dust such as asbestos, dust, coal or other chemicals. This information was essential to be provided because to understand the extent of cell damage and the incidence of silicosis\textsuperscript{12}. In addition, medical history of co-morbidities was not mentioned because there are several diseases that precipitate the occurrences of silicosis\textsuperscript{12}.

Finally, alcohol drinking behavior of the workers was unknown. Since silicosis is accompanied by various diseases including tuberculosis (TB) and there is a significant correlation exist between the intake of alcohol and occurrence of TB. Although Lonroth et al.\textsuperscript{13} has suggested in his investigational study that low to moderate intake of alcohol have no profound effect on the risk of TB but substantial increased intake about 40 g alcohol per day or individual having alcohol use disorder has increased susceptibility in the incidence of pulmonary tuberculosis.

5. CONCLUSION
The present study aids in understanding the exposure of silica that brick and tiles workers both are equally exposed and are equally affected by the silica inhalation and there is no correlation between the cell damage of the workers working in bricks operation and their duration of service. However, a certain level of association exists among the cell damage of tile workers and their length of service. Apart from LDH estimation, various other measures can be taken into account for the determination of silica exposure. Hence, the industry must consider the health and safety issues of the workers and provide them with best protective measures to ensure the effective and dedicated duties from their employees.

REFERENCES