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Evaluation of the effect of exposure to coal mine dust on the lipid profile and liver function markers

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ABSTRACT

Workers exposed to coal mine dust for a long duration up to 20 years may come across health risks associated with heart and liver. A lipid profile is a component of cardiac function assessment. For assessing liver functions, 4 principal enzyme markers associated with liver were considered. Hence lipid profile and enzyme markers for liver function were investigated in this study. 120 normal population and 120 coalmine workers (both male and female) who were exposed to the coal mine for periods ranging from 10 to 20 years were enrolled for this study. Results available in the laboratory data for a master health check on population not exposed to a coal mine and those who have been exposed to 10 to 20 years were made use of for this study. The mean levels of both lipid profile and liver functions tests were found to be highly and significantly different for coal mine dust exposed cases compared to controls ($p < 0.0001$). Surprisingly, the levels of most of the markers were within the normal limits and thus were clinically insignificant. A significant difference was observed with alkaline phosphatase. This study has demonstrated that biochemical tests should be done at regular intervals of time to monitor the incidence of health disorders associated with principal organs.



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INTRODUCTION

Coal is an important trade commodity and is the major fuel for generating electricity. Coal consumption increases each year, and the largest consumers of coal are China, US and India (Laney and Weissman, 2014). In India, more than 10 states produce coal. Lignite brown coal is mainly produced in Neyveli Lignite Corporation (NLC) situated in Tamil Nadu.

Long exposure to coal mine dust will result in various health risks such as the development of diabetes and problems associated with kidney, liver, cardiac, and reproduction. Majority of permanent coalmine workers are exposed for periods up to 20 years, and both male and females are equally employed in coal industries. Studies involving the health implications of coal mine workers, particularly in India are very few, and the literature data available are scarce. The data so available report on the lung and hematological parameters at large (Perret *et al.*, 2017).

This study was undertaken to assess the health implications associated with cardiac and liver functions of both males and females above 30 years who were exposed to coal mine dusts for periods ranging from 10 to 20 years. This study was aimed at evaluating the cardiac and liver functions of coal mine workers and to compare the results obtained on age-matched controls and to predict if coalmine workers are prone to health-related problems associated with cardiac and liver.

METHODS

This study is an open parallel prospective non-randomized, concurrent control vs a patient group with age and sex-matched population.

Study participants

Males and females in the age group of 40-55 years exposed to lignite mine work for 10 years (N = 60). Males and females in the above age group who were exposed to lignite mine works for 20 years (N = 60) were enrolled as a study group.

Males and females in the age group of 40-55 years who were residents of Neyveli Township and were not directly exposed to lignite mine dust but attended the NLCIL general hospital for routine health check-up and periodical medical examination during the preceding 10 years (N=120) served as controls.

Approval from NLCIL (NLC India Limited) and Chief General Superintendent/Medical of NLCIL General Hospital was obtained for this study before the commencement of data collection. All the controls and patients were identified by a unique identification number and patients' initials. Patients' information and the results obtained on blood samples were kept confidential.

Exclusion criteria

Workers and residents who were under any medication were not included. Smokers and alcoholics were also excluded.

Measurement of Biochemical Parameters

For the measurement of lipid and liver profile parameters, Roche c311 fully automatic analyser, Beckman Coulter AU680 fully automatic biochemistry analyser and reagents, calibrators and controls supplied by them were used. Preci control clinical chemistry level 1 & level 2 and Bio-Rad accuracy controls at two levels were used for all the parameters measured in this study to validate the reliability of results obtained for this study.

Statistical Calculations

GraphPad software was used for statistical analysis and calculation of mean and the significance of the difference in the mean.

RESULTS

The results obtained were subjected to statistical analysis using GraphPad software to obtain t and p values by comparing each parameter between controls and patients. A p value of <0.05 was considered significant.

Figure 1 presents the results obtained for males for controls and workers exposed to coal mine dust for

10 and 20 years. It is therefore clear from this comparison that those workers who were exposed to the lignite coal mine for 10 years have a significant alteration in these parameter levels compared to controls. Both the lipid and liver profile test results are significantly different for the study group compared to controls ($p < 0.0001$).

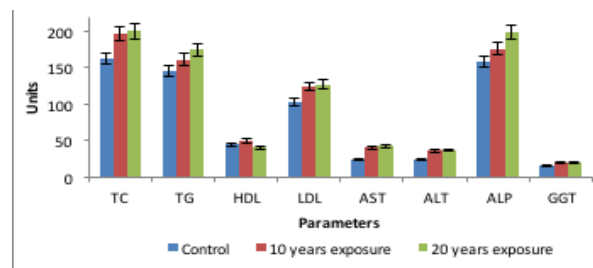


Figure 1: Lipid profile and liver enzyme markers of Controls and Coal mine dust exposed male workers

All the values represented here are Mean \pm S.D and N = 60. TC – Total Cholesterol, TG – Triglycerides, HDL – High-Density Lipoproteins, LDL – Low-Density Lipoproteins, AST – Aspartate Aminotransferase, ALT – Alanine Aminotransferase, ALP – Alkaline Phosphatase, GGT – Gamma Glutamyl Transferase

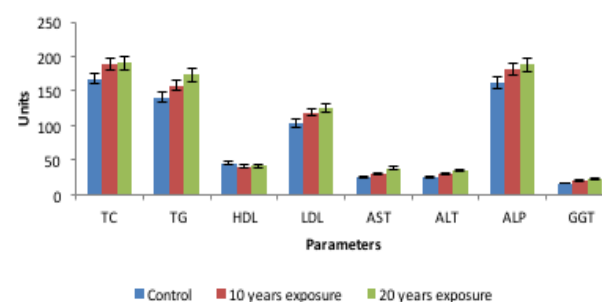


Figure 2: Lipid profile and liver enzyme markers of controls and coal mine dust female workers

All the values represented here are Mean \pm S.D and N = 60. TC – Total Cholesterol, TG – Triglycerides, HDL – High-Density Lipoproteins, LDL – Low-Density Lipoproteins, AST – Aspartate Aminotransferase, ALT – Alanine Aminotransferase, ALP – Alkaline Phosphatase, GGT – Gamma Glutamyl Transferase

Figure 2 summarizes the statistical parameters for female controls and workers exposed to the coal mine for 10 years and 20 years respectively. Both lipid and liver profile test results are significantly different for the study group compared to controls ($p < 0.0001$).

DISCUSSION

Coal is wide as an energy source around the world. Coal miners, underground miners, in particular, are constantly exposed to coal mine dust. This exposure results in a hazardous, irreversible effect on the health of the miners. Exposure to coal dust

results in detrimental effects on internal organs, primarily, the lungs. However, chronic exposure to coal dust for ten or more years affects the heart, liver and kidney (Costello *et al.*, Dharmage and Stewart, 2017).

Although some studies have been done on the effect of coal mine dust on the health implications of workers, studies based on such effects on individual organ function tests and the alterations in biochemical test associated with each organ are relatively very few. All that appears in the research fields are generalised alterations in the functioning of cardiac and liver, but not on the alterations in the biochemical parameters associated with these organs (Hendryx and Jullig, 2009, Esh and Hendryx, 2011)

In this study, the lipid and liver profile of males and females who were continuously exposed to coal mine environments for periods ranging from 10 to 20 years were compared with age and sex-matched populations who were not directly exposed to coal mine dust. All the lipid parameters were significantly different from the control population. The level of cholesterol in both males and females was much within the normal limit and thus was clinically insignificant. The levels of the remaining parameters namely triglycerides, HDL and LDL, were abnormal and thus may predispose to associated diseases. The findings in the study were found to be in accordance with previous observations made by Prasad *et al.*, on coal miners of West Bengal (Prasad *et al.*, 2017). Since the levels of lipid profile components were found to be significantly different from normal population levels, such alterations may lead to CVD and other cardiac-related disorders (Chereskov *et al.*, 1995, Chenjing *et al.*, 2018).

The enzyme markers for liver function were also found to be significantly high in the coal mine workers when compared to the controls. However, except ALP, the other parameters namely ALP, AST and GGT were within normal limits and thus the observations were clinically insignificant. These findings are in agreement with previous studies (Lefevre *et al.*, 1982, Driscoll *et al.*, 1995).

Moderate liver enlargements up to 10-20% among coal mine workers have been observed compared to normal population; however, the enlargement did not show any pathological abnormalities in a study reported by Lefevre *et al.*, 1982. A significant correlation was observed between pigment score in both liver and spleen and pneumoconiosis. Such scores also showed relation to the number of years exposed to coalmine. Hence cumulative lifetime exposure to coal mine dust will certainly affect both liver and spleen (10). In another study, workers exposed to silicon environment showed increased

Gamma GlutamylTranspeptidase (Y-GT) levels. Logistic regression analysis revealed abnormal Y - GT and ALT with all types of coal mine workers (Zawilla *et al.*, 2014)

The study was conducted on coal mine workers who were exposed to 10 years and 20 years. Hence, the comparison between these two groups of miners becomes necessary to understand the effect of prolonged exposure to coal mine dust. The lipid profile of both males and females did not exhibit any significant change in 20 years' exposure group when compared to the 10 years' exposure group. This is indicative of the safety measures adopted by the NLC.

In a study involving lignite liquefaction, factory workers exposed to less than 8 years did not show any alterations in Haematological, biochemical, endocrine, or lung functions. Longer duration of exposure may affect such functions (Zawilla *et al.*, 2014).

NLCIL Management has been taking a timely intervention to safeguard the employees by doing a regular periodical medical examination and routine medical checkups. Safety measures like safety uniform, shoes, safety glasses, helmets, masks and other safety measures are also in practice to minimize the health problems of the employees.

CONCLUSION

This study was performed using coal mine workers who are exposed to coal mine dust for a period ranging from 10 to 20 years. Both male and female coalmine workers are equally affected if they are exposed to a long period of up to 20 years. Both lipid profile and liver functions were found to be significant compared to age and sex-matched controls. Routine screening of organ function tests is necessary to ascertain the health status of these two organs.

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