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Effect of chronic exposure of wood dust on serum malondialdehyde, C-reactive protein in sawmill workers and their correlation with pulmonary function parameters.

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ABSTRACT:

Background: Exposure to wood dust reduces the pulmonary function and it may cause inflammation and oxidative damage. A correlation of the biochemical parameter to the spirometric values of lung function parameters may be useful in selecting an alternative test parameter to assess lung function in conditions where performing spirometry is difficult.

Objectives: Assessment of biomarker of oxidative stress, malondialdehyde (MDA), and inflammatory marker, c-reactive protein (CRP) along with pulmonary function test parameters, forced expiratory volume at first second (FEV_1), forced vital capacity (FVC) and their ratio (FEV_1/FVC) in sawmill workers and comparing with non sawmill workers.Correlation of biomarkers with pulmonary function test results.

Methods: Spirometric measurements were taken by advising the subjects to breathe through the instrument. Serum MDA and CRP were estimated in the collected blood using standard procedures.

Results: Significantly elevatedSerum MDA and CRP and lower lung function parameters, FEV_1, FVC and FEV_1/FVC were observed in sawmill workers compared to non sawmill workers. A significant positive correlation was observed between FVC and MDA with CRP. FEV_1/FVC showed a significant negative correlation with MDA.

Conclusion: Serum MDA and CRP were high in sawmill workers. Serum MDA may be used as an indicator of reduced pulmonary function in case of difficulty in performing spirometry.

Key words

MDA, CRP, spirometry, pulmonary function test.

1. Introduction

Workers of sawmill are susceptible to occupational exposure of wood dust, which may cause cytotoxic effects leading to inflammation and release of reactive oxygen species [1], which are responsible for the development of oxidative stress at the cellular level. The inflammation may lead to the fibrosis of the lung tissues, thus defective oxygen diffusion and impaired lung functions[2]. The measured values of certain spirometric parameters like FEV1, FVC and FEV1/FVC may be useful in identification of obstructive or restrictive lung defects[3]. In a study conducted on workers of wood industry, the vital capacity (VC) and FEV1 were found to be lower than expected[4]. Similar observations were recorded by another study on sawmill workers[5]. Exposure to wood dust was found to cause increased levels of serum CRP and MDA[1].

We observed a lacuna in the existing knowledge where the decreased pulmonary function capacity was not correlated with the biochemical markers of inflammation and oxidative stress. This correlation may be useful for the clinician for a better diagnosis, especially in patients in whom spirometric assessment of pulmonary function parameters is difficult. Thus, in the present study, we aimed at assessment of biochemical parameters, MDA and CRP along with pulmonary function test parameters, Forced Expiratory Volume at first second (FEV1), Forced Vital Capacity (FVC) and their ratio (FEV1/FVC) in people working in sawmill and comparing the results obtained with age and sex matched controls. We also aimed at correlating the results of biochemical markers with pulmonary function test results.

2. Materials and methods

The study included sawmill workers as test subjects and age and sex matching non sawmill workers as control.

The sample size was calculated by taking consideration of a previous article related to the similar work [6] using the formula,

$N= [(1/q_1+1/q_2)\ S^2\ (Z_\alpha+Z_\beta)^2] / E^2$

Where,

N- sample size

q_1– control mean

q_2- study means

S- SD in cases

$E= q_1- q_2$– effect size.

The minimum number we got by this formula was 67 and we kept the sample size of 70. Thus the study contained 70 subjects of both the gender between the ages18-65 years. We involved 35 sawmill workers, who have been working for a minimum period of one year as case and 35 age and sex matched non-sawmill workers as control. We took permission from the nearby sawmill, approached the workers and explained them about the project work. Consent about participation was obtained from willing workers. Any worker who did not give consent,or who had earlier been diagnosed of any acute or chronic inflammatory diseases, infections and pulmonary diseases was excluded from the study. Consent was collected from the control population as well. Institutional ethics committee clearance was obtained before starting the project work.

2.1. Protocol

The subjects were approached and were explained about the carrying out of the study protocol. They were asked not to smoke for at least one hour before pulmonary function testing, not to eat a large meal two hours before testing and not to wear tight fitting clothing during the test[7]. Personal information along with the family history and past history of illness and medications was gathered by interacting with the subjects, general physical examination and systemic examination was done and the findings were noted down.

The subjects were asked to sit on a chair, to take a deep breath and were asked to exhale into the mouthpiece of Easy One Connect computerized Spirometer. The pulmonary function parameters studied were FVC, FEV1, FEV1/FVC.

Blood was drawn in a plain vacutainer, serum was collected and was used for the following biochemical investigations:

1. Estimation of CRP was done by immunoturbidimetric method using CRP kit from LabcareCompany in chemistry analyser,Selectra Pro S from EliTech group solutions as per the standard procedures[8].

2. MDA levels was estimated by measuring thiobarbituric acid reactive substances using UV/Vis AnalyserLabotech from BD Instrumentation using standard procedures[9,10].

2.2. Statistical analysis

Statistical software SPSS-20was used for the analysis. Qualitative data was represented as frequency and percentage. Quantitative data was expressed as mean ± SD for both case and control group. Comparison of serum MDA, CRP and pulmonary function parameters between cases and control was done using independent t-test. Correlation between serum MDA, CRP and pulmonary function parameters was done using Pearson's correlation test. Chi-square test was used for determining the association of duration of exposure to wood dust on serum MDA, CRP and pulmonary function parameters in cases. $p<0.05$ was considered statistically significant.

3. Results:

3.1: Table 1 shows the age wise distribution of study population. 35 people working in sawmill were taken as cases and 35 people not working in sawmill were taken as controls. Majority of the study population belonged to the age group of 31-40 years.

3.2: Table 2 explains the comparison of mean values of BMI, respiratory rate, FEV1, FVC, FEV1 / FVC, CRP and MDA in cases and controls. A statistically significant decrease in the pulmonary function parameters and increase in serum CRP and MDA levels is seen in sawmill workers when compared to non-sawmill workers.

3.3: A correlation between the pulmonary function parameters, FEV1, FVC, FEV1 / FVC and serum CRP and MDA is explained in Table 3. FEV1 showed a statistically significant positive correlation with FVC and CRP. FVC showed a statistically significant positive correlation with CRP. FEV1/ FVC showed a statistically significant negative correlation with MDA. CRP shows a statistically significant positive correlation with MDA.

3.4: Table 4 shows the duration of exposure of wood dust in sawmill workers. Majority of the study population belonged to the range between 6 and 15 years of exposure.

3.5: Table 5 shows the association of FEV1, FVC, FEV1 / FVC. CRP and MDA to the duration of exposure to the wood dust in cases. There was no statistically significant association between FEV1, FVC, FEV1 / FVC, CRP and MDA to the duration of exposure to the wood dust.

4. Discussion.

The spirometric values of FEV1, FVC and FEV1 / FVC calculation may be useful in identification of obstructive or restrictive lung defects[3]. A FEV1 / FVC ratio < 70% is an indicator of obstructive pulmonary disorder where decrease in FEV1 is more than FVC[3], where as in restrictive lung diseases both FEV1 and FVC are reduced. Thus,based on our findings, we may be able to say that obstruction to pulmonary system is less significant in sawmill workers in the present study. However, the ratio was significantly lower in sawmill workers compared to non-sawmill workers. FEV1 measurements are usually done to assess the mechanical properties of the lungs and the values are reduced in both obstructive and restrictive pulmonary diseases[10]. In the present study, a significant reduction in FEV1 in sawmill workers compared to the non-sawmill working controls maybe an indicator of pulmonary functioning abnormality in sawmill workers, similar observations were recorded by previous studies as well[5,11,12].

Lung volume may be measured in terms of FVC and the values are reduced in the restrictive pulmonary disorders. However, severe obstruction in the lungs may also lead to reduction in FVC, thus it may not be a relative indicator of restriction or total lung capacity[10]. Lower levels of FVC among sawmill workers coincide with the previous studies[5,11], indicator of poor pulmonary function. Minute saw dust particles may be inhaled by the workers which might have caused the infection of the respiratory system and obstruction to the airways.

The marker of inflammation, CRP and marker of oxidative stress, MDA were significantly increased in sawmill workers when compared to non-sawmill working controls. CRP is an acute phase protein, the level of which determines the intensity of inflammation[11]. CRP is one of the first acute phase protein that is associated with air pollution[13]. A correlation between ambient particle exposure and CRP levels in serum was found in children below 18 years, but poor association was found in adults[14]. Increased levels of CRP also have an association of doubling the risk of coronary heart disease[14]. Present observation is in accordance with the findings of Wultusch et al,[1], where they compared the CRP levels between the workers who were exposed only to wood dust and those who were exposed to wood dust as well as volatile

organic compounds. Elevated CRP levels in the workers of sawmill maybe plausibly due to exposure to wood dust which is known to cause respiratory infection and inflammation[13,15].

Measurement of MDA, one of the markers of oxidative stress, is done by assessing thiobarbituric acid reactive substances. MDA is used as a biomarker of oxidative stress in many disorders like chronic obstructive pulmonary diseases[16]. Exposure to wood dust might cause cytotoxic effect which lead to elevated oxidant levels and the antioxidant protection might have been reduced due to this cytotoxic effect itself. As a result, the level of MDA might have been elevated.

Exposure to wood dust might have resulted in the obstruction or restriction of pulmonary airways due to inflammation and oxidative stress. This might have indicated by significant negative correlation between pulmonary function parameter FEV1, FVC and FEV1/FVC and MDA. There was a significant positive correlation between CRP and MDA. Absence of association of duration of work with the pulmonary function parameters, MDA and CRP may be because initial exposure of worker to sawdust itself might have caused infection and inflammatory response.

5. Conclusion

Exposure to wood dust reduces the pulmonary functioning capacity, causes inflammatory responses and increases the oxidative stress. A correlation of pulmonary function parameters with markers of inflammation and oxidative stress is the novelty of the present work. This observation may be useful for clinicians especially to deal with patients where performing pulmonary function test may not be possible. However, assessment of antioxidant levels has not been done in the present study. This would be the scope for the future research in this area. The sawmill workers were provided with safety face mask but the poor awareness about the use of this mask were observed in the study. Thus it may be inferred that effective control measures on dust exposure and education regarding the usage of provided personal protective equipments is mandatory for sawmill workers.

Author contribution

All the authors agree to be accountable for all aspects of the work and all the aspects of the project work are performed appropriately.

A- Performed all the analysis and assisted in writing the draft of the manuscript.
B- Contributed in initial drafting and revising the final version of the manuscript.
C- Wrote the first draft of the manuscript, contributed for the conceptualization and design of the work.

All the authors approved the manuscript.

Disclosure of interest

The authors declare that they have no competing interest.

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Conflicts of Interest:

None.

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Author's statement:

We, the authors declare that the manuscript has been read and approved by all three of us.

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Table-1. Age wise distribution of study population.

Age groups	Cases (n=35)	Controls (n=35)
20-30	8	8
31-40	10	10
41-50	8	8
51-60	8	8
61-65	1	1

Table 2: Comparison of mean values of BMI, respiratory rate, FEV_1, FVC, FEV_1 / FVC, CRP and MDA in cases and controls.

Parameters	Cases(n=35)	Controls(n=35)	p value
BMI (kg/m^2)	22.16±4.21	24.55±3.25	<0.05*
Respiratory rate	17.49±2.38	17.03±1.93	0.38
FEV_1 (L)	2.78±0.59	3.48±.0.47	< 0.01*
FVC (L)	2.24±0.48	3.04±0.45	< 0.01*
FEV_1 / FVC (%)	80.42±9.24	87.18±2.65	< 0.01*
CRP (mg/L)	7.76±4.65	2.93±2.70	< 0.01*

MDA (µmol/L)	82.28±8.02	45.20±5.58	< 0.01*

Values expressed as mean ± SD. * - indicates statistical significance.

Table-3. Correlation between FEV_1, FVC, FEV_1/FVC, CRP and MDA in cases.

Parameters	**FEV_1**	**FVC**	**FEV_1/FVC**	**CRP**	**MDA**
FEV_1 (L)	1	0.874*	-0.257	0.505*	0.228
FVC (L)	0.874*	1	0.221	0.545*	0.096
FEV_1/ FVC(%)	-0.257	0.221	1	0.053	-0.358*
CRP(mg/L)	0.505*	0.545*	0.053	1	0.362*
MDA (µmol/L)	0.228	0.096	-0.358*	0.362*	1

The values expressed above are "r" values ***- statistically significant**

Table-4. Duration of exposure of saw dust among the cases.

Years of exposure	**Number of sawmill workers(n=35)**
1-5	8
6-15	14
>16	13

Table 5: Association of FEV_1, FVC, FEV_1 / FVC, CRP and MDA to the duration of exposure to the wood dust in cases.

Parameters	p value
FEV_1 (L)	0.431
FVC (L)	0.125
FEV_1 / FVC (%)	0.629
CRP (mg/L)	0.729
MDA (µmol/L)	0.106