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Original Article

Evaluation of Pulmonary Function in Rice Mill Workers

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Abstract

Background: There is paucity of data emanating from vulnerable population who are employed one in the prominent dust generating industries in this region including rice mills. The present study aims to study the effect of paddy husk exposure on pulmonary functions in rice mill workers of Kolar.

Materials and Methods: 250 rice mill workers and 250 age matched unexposed subjects were recruited based on various inclusion and exclusion criteria &Pulmonary Function Tests were performed.

Results: There was significant reduction of FVC, FEV_1, PEFR in the exposed population ($p<0.001$) and significant increase in FEV1/FVC ratio ($p<0.043$) as compared to unexposed subjects. There was no significant difference in pulmonary function between rice mill workers with duration of exposure lesser than 5 years, 5-10 years and greater than 10 years.

Conclusion: There was impairment in pulmonary functions in rice mill workers. There is early impairment of pulmonary function after exposure which does not seem to deteriorate further suggesting that severity of exposure might play a more significant role in further deterioration rather than duration of exposure alone. FEV1/FVC was above 70% indicating restrictive lung disease.

Introduction

Dust pollution is a global health hazard both in developing and developed countries. Many industries have different types of dusts released as byproducts of its product manufactured causing severe dust and air pollution. Rice is the largest staple food in India with more number of rice mills. Rice mills give rise to a small part of organic dust pollution among other industries that generates dust. Respirable dust exposure has been found to be highest in rice mill workers as compared to other industries that emit dust like oil mill, floor mill etc. (1). Rice milling is the process that helps in removal of hulls and bran's from paddy grains to produce rice suitable for consumption. The emissions are generated from various sections during handling of paddy; cleaning

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& milling of paddy; handling and storage of husk and handling, storage and disposal of boiler ash due to various activities in the mills. Dust particles smaller than 10 µ has adverse respiratory impairments like chronic bronchitis, similar to that of silicosis. As rice husk is made of 90% of silica, it causes damage to bronchial passages, along with damage to the elastic component of alveolar walls (2).

Similar study shows in rice mill workers On comparison with control group found significant decline in FVC, FEV1, PEFR (3, 4). Pulmonary function tests provide an objective and quantifiable measure of lung functions (5). In occupational respiratory abnormalities spirometry is the most frequently performed pulmonary function test (PFT) for both screening and clinical evaluations (6) & provides effect of obstructive or restrictive pattern of respiratory disorder. There has been evidence documenting both duration and severity of exposure affecting pulmonary function. Keeping in view the hazards of paddy husk on pulmonary function, the present study aims to study the effect of paddy husk exposure on pulmonary functions in rice mill workers.

Materials and Method

A community based cross sectional study was conducted in the premises of rice mills at Kolar district. After institutional ethical clearance for the study and informed consent, 250 male rice mill workers between the ages of 20-40 years and 250 age matched unexposed males were recruited for the study. Workers with history of smoking, diabetes mellitus, tuberculosis, bronchial asthma, malignancy, neuromuscular disorders, thoracic cage abnormalities, spine abnormalities and any history of surgery were excluded from the study. The rice mill workers were categorized based on their work in different milling activities as loaders, paddy pourers, paddy cleaning section workers, boiler section workers, destone section workers, paddy hulling section workers, blowers in husk section, bran section workers and ash section workers. Demographic characters like age, height and weight from both rice mill workers and unexposed group was collected. Additional information regarding duration of exposure was documented. Pulmonary functions were compared in 3 subgroups of rice mill workers classified based on years of exposure as lesser than 5 years, 5-10 years & greater than 10 years.

Spirometry was performed using the instrument SPIROTECH and the study was conducted at the same time on all the days to rule out diurnal variation. Before starting the lung function tests, the subjects were asked to loosen their tight clothing. Spirometry was performed after demonstration of the required procedure. The subject was asked to take deep inspiration from environment followed by forceful expiration into the mouth piece of the SPIROTECH in standing posture. The mouthpiece should be inserted without leak of air or obstruction by the lips or teeth and forced expiration continued to completion without a pause and without leak of air around the mouthpiece & inspire rapidly again to maximum capacity with nose closed. Lung volumes and capacities (FVC, FEV_1, PEFR and FEV_1/FVC ratio) were obtained, by repeating the procedure 3 times and the best of the three values was taken & was expressed with correction for body temperature at the ambient pressure, saturate with water vapour (BTPS) (7).

Statistical analysis

SPSS 17.0 was used for the statistical analysis. Descriptive statistics was used for qualitative data. Student t test and ANOVA followed by post hoc analysis were done to analyse the quantitative data. The data was presented as a mean ± standard deviation. Independent t-test was applied to compare the measured general characteristics and pulmonary function values between rice mill workers and unexposed group. One-way ANOVA was done to compare FEV1, FVC, FEV1/FVC & PEFR among the subjects associated with different milling activities in rice mill workers and Post Hoc Bonferroni test was done to know which category was affected most in comparison with other categories. One way Anova was done to compare pulmonary function tests between rice mill workers grouped based on duration of exposure to evaluate the effect of duration of exposure on pulmonary function impairment. Level of significance was set at $p<0.05$.

Results

There was no significant difference for age & BMI among rice mill workers and unexposed. There was a significant reduction of FVC, FEV_1, PEFR and FEV_1/FVC ratio among the exposed population as compared to unexposed population.

TABLE I : Independent 't' test Comparing Age, BMI & pulmonary function test in Exposed and Unexposed groups.

Parameters	*Unexposed Mean±SD*	*Exposed Mean±SD*	*p value*
Age(years)	31.66±5.29	30.83±5.80	0.092
BMI(Kg/m^2)	22.65±3.03	22.38±3.60	0.377
FVC(L)	3.13±0.52	2.87±0.77	0.001**
FEV_1(L)	2.86±.60	2.57±0.57	0.001**
PEFR(L/sec)	6.92±1.21	4.61±1.31	0.001**
FEV_1/FVC%	91.75±12.54	90.50±8.99	0.043*

In One way Anova test showed no significant difference in pulmonary function in rice mill workers grouped according to duration of exposure in exposed group.

In this study majority of workers was in paddy pouring section i.e. 22.4% followed by sections involving loading the rice (18.4%) and Ash removal (14.4%).

One-way ANOVA test showed that there was significant difference between the groups with respect to PEFR.

POST HOC analysis using BONFERRONI criteria for significance of PEFR was significantly lower in ash section workers as compared to other categories of rice mill workers ($p<0.05$).

TABLE II : Comparison of PFT grouped according to duration of exposure among exposed group in rice mill workers by One-way ANOVA test.

Duration of exposure (years)	*FVC(L) Mean±SD*	*FEV1(L) Mean±SD*	*PEFR(L/sec) Mean±SD*	*FEV1/FVC% Mean±SD*
<5 yrs (n=27)	2.84±0.64	2.49±0.46	6.82±2.18	90.68±9.51
6 to 10 yrs (n=122)	2.77±0.80	2.44±0.62	7.0425±2.67	89.92±11.73
>10 yrs (n=101)	2.60±0.80	2.3623±0.61	6.31±2.48	91±12.36
F Value	1.646	0.727	2.256	0.239
p value	0.195	0.484	0.107	0.788

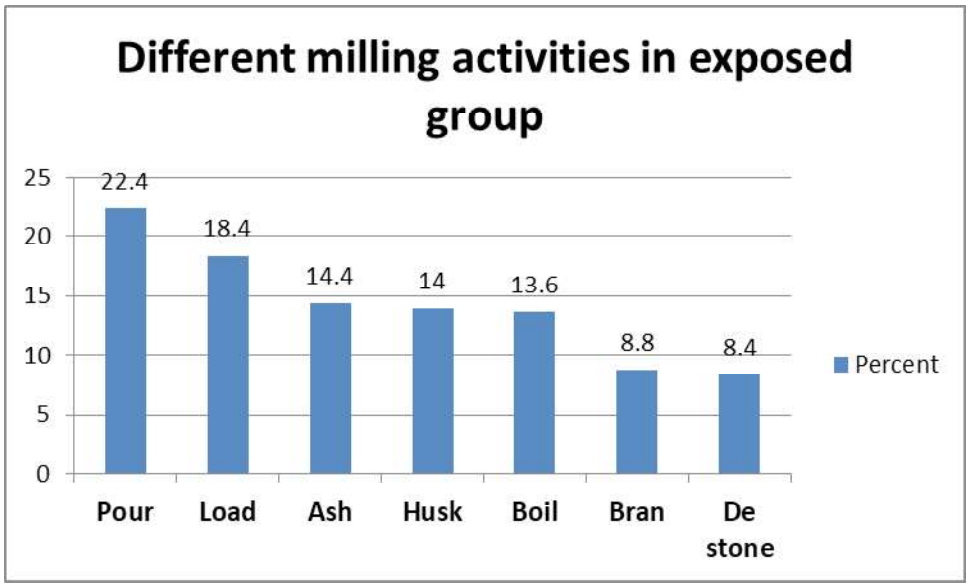

Fig. 1 : Bar diagram showing distribution of work in different milling activities in rice mill workers.

TABLE III : ONE WAY ANOVA results comparing FVC, FEV1, PEFR AND FEV1/FVC among the different millingactivities in exposed groups.

Variables	*Different Milling Activities*							*P value*
	Pour	*Load*	*Ash*	*Husk*	*Boil*	*Bran*	*De stone*	
FVC(L)	2.58±0.74	2.98±0.81	2.87±0.67	2.96±0.73	3.07±0.76	2.91±0.79	2.93±0.82	0.066
FEV_1(L)	2.38±0.63	2.56±0.52	2.56±0.50	2.61±0.51	2.80±0.56	2.65±0.62	2.59±0.58	0.061
PEFR(L/sec)	4.39±1.01	4.45±1.39	5.81±1.38	4.45±1.17	4.86±1.13	4.23±1.26	3.77±0.90	0.001*
FEV_1/FVC%	92.57±8.28	88.37±11.16	90.78±7.02	88.22±9.90	90.89±70.58	92.21±7.71	90.49±9.59	0.192

TABLE IV : POST HOC BONFERRONI TEST comparing means of PEFR between different milling activities of rice mill workers in exposed group.

	Ash	*Boil*	*Bran*	*Destone*	*Husk*	*Load*	*Pour*
Ash		P=0.023*	P=0.001*	P=0.001*	P=0.001*	P=0.001*	P=0.001*
Boil	P=0.023		P=1.000	P=0.027	P=1.000	P=1.000	P=1.000
Bran	P=0.001*	P=1.000		P=1.000	P=1.000	P=1.000	P=1.000
Destone	P=0.001*	P=0.027	P=1.000		P=0.868	P=0.701	P=0.959
Husk	P=0.001*	P=1.000	P=1.000	P=0.868			P=1.000
Load	P=0.001*	P=1.000	P=1.000	P=0.701	P=1.000		P=1.000
Pour	P=0.001*	P=1.000	P=1.000	P=0.959	P=1.000	P=1.000	

Discussion

Dust pollution has lot of deleterious effect on respiratory health. In our study, PFT was recorded in rice mill workers (exposed) and compared it with age & BMI matched unexposed groups to evaluate the effect of dust pollution in people working in the rice mills, and it showed significant decrease in FVC, FEV_1, PEFR and FEV1/FVC in exposed group.

The decline can be explained by the demonstrating the effect of dust emitted during the processing of paddy in the various milling activities. During milling of paddy about 78% of weight is received as rice, broken rice and bran. Rest 22% of the weight of paddy is received as husk. This husk is used as fuel in the rice mills to generate steam for the parboiling process. During milling of paddy about 78% of weight is received as rice, broken rice and bran. Rest 22% of the weight of paddy is received as husk. This husk contains about 75% organic volatile matter and the balance 25% of the weight of this husk is converted into ash during the firing process, is known as rice husk ash. This rice husk ash in turn contains around 85%-90% amorphous silica. The pathophysiology of impairment of lung functions among rice mill workers is most likely due to the deposition of rice mill dust particles smaller than 10 μ called respirable dust, consisting of husk dust & its ash which consists of 90% of silica (1) which that gets deposited in the lungs by inhalation. This causes irritation and inflammatory reactions and healing of this inflammatory process would cause fibrosis leading to defective oxygen diffusion and impaired pulmonary function (8). This may lead to pulmonary dysfunction of the restrictive type. The FEV_1 and FVC are significantly reduced in rice mill workers as quoted earlier but the FEV_1/FVC was above 70% showing a restrictive type of abnormality which is also recorded by many others (9, 10). Rice Husk dust causes damage to bronchial passages, along with damage to the elastic component of alveolar walls. Rice husk dust contains some air borne endotoxins which cause inflammatory reactions in Broncho-pulmonary system (11).

The decrease in PEFR was significant among rice mill workers which may be again due to increased dust exposure. Peak flow is mainly a function of the large caliber airways. It greatly depends on expiratory muscle strength. Decrease in PEFR is probably due to hypertrophy of mucosal cells due to irritation by grain dust and smoke resulting in the increased secretion of mucous and formation of mucosal plugs which cause obstruction to the exhaled air (12).

The present study showed decline in pulmonary function in workers exposed to rice mill dust as reflected by significant decline in lung parameters FVC, FEV_1, PEFR and FEV_1/FVC ratio (Table-II). The decrease in FVC may be due to changes in the bronchi and elastic component of lungs resulting in restrictive type of lung impairment (13). Decrease in FEV_1 indicates exposure to dust leading to early obstructive pulmonary impairment. A study showed that there was comparative decrease in PEFR/min within 1 year after the workers joined the job (14). Similar results are obtained in our study which shows early impairment of pulmonary functions within 5 years of exposure which did not deteriorate further on increase in duration of exposure. Similar studies showed the values of respiratory parameters goes on decreasing with increase in number of years of exposure to rice husk (3, 4). The results differ from few studies where the pulmonary function tests declined with increasing duration of exposure to dust where FVC goes on decreasing with increased duration of exposure of rice husk dust (15) which further decline with increase in number of years of exposure (16). The severity of exposure may hence play an important role in further decline in pulmonary function rather than mere increase in duration of exposure.

In our study One-way ANOVA test showed that there was significant difference in PEFR between the workers recruited from different milling activities. PEFR was significantly reduced in pourers, loaders, workers of husk section, boil section, bran section & destone section as compared to ash section workers and this may be due to release of air borne endo-toxin which may cause inflammatory reaction in the Broncho-pulmonary system (17). Dust emission is relatively high in theses sections because of greater working area that increases dust concentration & hence effects of exposure may be more evident in these sections as compared to ash section (18). During loading or unloading of ash which is temporarily stored in a shed or chamber where the access is only from front side for ash removal purpose, water is spread periodically to keep ash in wet condition so that top layer remains wet, thereby preventing blowing of ash particles due to wind which further contributes to lessor dust emission (19). Literature has documented the dust emissions from different sections i.e. dumping of rice at a place for subsequent collection in gunny bags, feed of paddy from gunny bags to the dumping pit, cleaning of paddy grains, removal of husk from the paddy and polishing of rice as the major dust hazard in rice mill workers (1). Thus by rotating the workers to different milling activities at regular intervals would reduce the risk of harmful effects of airborne particles that are predominantly more concentrated in certain milling activities.

Earlier studies in rice mill workers have shown considerable variations in dust exposure in different activities in the rice mills with greater dust concentration in feeding areas. Results from those studies have shown total dust exposure to all the workers were higher than the permissible exposure limit (20). Thus, reduction of dust exposure among the workers is necessary for preventing respiratory system impairment.

Management and supervisors were educated on the importance of prevention of health hazards at source by using engineering measures such as enclosure of dust and effective ventilation, pre-employment screening, education, training and supervision of workers, seeking advice for environmental monitoring by central pollution control board [CPCB] and getting health surveillance by conducting periodic medical check-up at least once annually.

Incorporation of Dust collection system in feeding and sieving section of rice mill by creating an air stream to capture the air borne dust. This modification has decreased the total dust concentration in the range of 56 to 58% at feeding-cum-sieving section. The respirable dust concentration decreased to 4.24 from 8.89 mg/m^3 after modification which comes under the recommended limit of 5 mg/m^3. Further, significant effect of modification was also observed at the polishing and packaging section (1). The same method may be used by others for the improvement of workers for their health and efficiency.

Conclusion:

PFT of rice mill workers was significantly reduced with FEV1/FVC above 70% indicating restrictive pattern of disease. Results of the study demonstrate that impairment in pulmonary function test sets in early, within 5 years of exposure and does not seem to deteriorate further suggesting that severity of exposure might play a more significant role than duration of exposure. PFT analysis served as a useful tool in early diagnosis of lung impairment among the rice mill workers.

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