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Original Research Article

A Cross Sectional Study of Spirometric Evaluation of Lung Functions and Respiratory Symptoms in Rice Mill Workers in Rural Region of Western Part of Maharashtra.

Rupali Sudhir Baburdikar[1], Manasi Mukund Joshi[2], Yuvraj Khema Badhe[3]

[1]Associate Professor, Department of Physiology, MAEER MIT PUNE'S MIMER Medical College Talegaon, Dabhade, Pune.

[2]Intern, Department of General Medicine, MAEER MIT PUNE'S MIMER Medical College Talegaon, Dabhade, Pune

[3]Assistant Professor, Department of General Medicine, MAEER MIT PUNE'S MIMER Medical College Talegaon, Dabhade, Pune

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Corresponding author: Rupali Sudhir Baburdikar
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Abstract

Introduction: Rice millworkers have an increased exposure to dust and chemicals which can have adverse effect on respiratory health of the workers. Spirometry is very important and widely used diagnostic tool for measuring obstructive or restrictive patterns of lung functions which can aid in early detection of airborne occupational health hazards.

Aim: The primary objective of the study was to determine Forced expiratory volume in 1st second (FEV 1), Forced vital capacity (FVC), and FEV1/FVC and Peak expiratory flow rate (PEFR) in the rice mill workers and to compare these parameters with the healthy individuals. The Secondary objective was to find the prevalence of respiratory symptoms among the rice mill workers

Materials and Methods: A community-based observational cross-sectional study was conducted in Maval region of Western part of rural Maharashtra. Spirometry test was done in 36 rice mill workers and spirometry parameters were compared with healthy age and sex matched controls. Unpaired t-test was used to compare mean values of FVC, FEV1 & FEV1/FVC ratio between the study groups.

Results: There was decrease in all spirometry parameters in rice mill workers when compared to healthy volunteers. The mean FVC in subject group was 2.7±1 while that in controls and control group was 3.6±0.6. The mean FEV1 in subject group was 1.7±0.7 while that in controls was 3±0.5. The mean FEV1/FVC in subject group was 64.1±5.6, while that in controls was 83.1±4.8. There was highly significant difference seen above mentioned spirometry parameters between the two groups with p value (< 0.0001).

Conclusion: Rice mill dust exposure affects the lungs functions as seen by decrease in spirometry parameters as compared to control group. Also, chest tightness was one of respiratory symptom experienced in majority (63.9%) of the rice mill workers.

Keywords: FEV1, FVC, FEV1/FVC, Rice Mill Workers.

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Introduction

Rice is one of the principal food crops of the country, forms an important part of the staple diet of Indians. India is the second largest rice producing country in the world after China. [1] India contributes about 20% of world output of rice and contributes more than 40% of the total food grain production. [2] Moreover, India has the largest area under paddy cultivation that is more than 42.8 million hectares. [1] Indian rice milling industry is the largest and oldest agro-based industry which includes rice production, processing and marketing and on which more than half (58.45%) of the Indian population depends majorly on agriculture for their livelihood. [3,4] Paddy is grown in almost all the states and parts of the country but West Bengal is the largest paddy producing state in India. Maharashtra ranks 13th in the country's rice production and the average production is lower in Maharashtra state than other rice growing states.

The cultivation of rice is generally carried out in an irrigated paddy field. After harvesting, it is dried and milled. [3] A rice grain is mainly made up of an external husk layer, middle layer of bran and inner most -the endosperm. Rice milling is the

process of removing the husk and the bran from the germ layer to produce edible rice. This process of removal of layers done by friction is called de husking or de-hulling. It was traditionally done by mortar and pestles but in modern rice mills, it is done by passing the rice grains between two abrasive surfaces and then separating it from the paddy. [5] The husk is removed by suction and then transported to the storage dump. Rice Mills contribute to a small part of organic dust pollution among other industries that generate dust. [6] The respirable dust exposure has been found to be highest in rice mill workers as compared to that of other industries that emit dust like oil mill, floor mill etc. [7] Grain dust has a long history of associated respiratory diseases and it adversely affects various organs of the body. [8] Rice mill workers have an increased exposure to dust and chemicals especially during handling, cleaning and milling of paddy as well as handling and storage of husk and ash. The rice husk is mainly made up of 90% silica which may have an adverse effect on respiratory health of the workers. [6] This biogenic silica may cause pulmonary diseases resembling pulmonary asbestosis, such as pleural thickening, pulmonary fibrosis or even lung carcinoma and also, may provoke chronic bronchitis, asthma, COPD. [9,10] The respiratory symptoms can be grouped mainly into 4 categories namely Morning cough, Morning cough with phlegm, Chest tightness, Shortness of breath. [11] The rice mill workers can suffer from occupational lung disease. Spirometry is very important and widely used diagnostic tool for measuring obstructive or restrictive patterns of lung functions. [12] So Occupational exposure to organic dust and endotoxin can cause various respiratory problems including bronchial asthma, allergic alveolitis, chronic bronchitis, toxic pneumonitis, acute or chronic lung function impairment. Air borne occupational health hazards can be minimized by improving ventilation, good work practices and use of personal protective equipment. [5]. Literature search could not reveal any documented study on spirometric evaluation of lung function and respiratory symptoms among rice mill workers in many parts of the country including the Maval region of Pune district, Maharashtra. There are few recent studies in other parts of India which showed a higher prevalence of respiratory morbidity among rice mill workers. [5,13]. With this, the study was carried out in Maval region of Pune district of Maharashtra. The primary objective of the study was to determine Forced expiratory volume in 1st second (FEV 1), Forced vital capacity (FVC), and FEV 1 /FVC and Peak expiratory flow rate (PEFR) in the rice mill workers and to compare these parameters with the healthy individuals. The Secondary objective was to find the prevalence of respiratory symptoms among the rice mill workers.

Materials and Methods:

A community based cross sectional observational, study was conducted in rural region of Western part of Maharashtra in the year 2021-22. After Institutional ethics committee approval for the study. The study was conducted in 4-6 regions of the locations mentioned above, each encompassing 5-8 rice mills, selection of the mills was done randomly. The timing and location of the study was as per the convenience of the rice mill workers (preferably on Thursdays as per their request). Apparently healthy, age and sex matched controls from the same village those who are not having any history of exposure of organic dust or chemicals in the past and those meeting the inclusion criteria were included. According to a previous study, the ratio of FEV1/FVC has been reported to be 90.50±8.99. [6] Considering this as type 1 error (α) =0.001 and allowable error of 5% the estimated sample size is calculated as follows so, the total sample size calculated was 36 in each group i.e. subject Group and control group. Sample Size Calculation: In a previous study, the ratio of FEV1/FVC has been reported to be 90.50±8.99(6). Considering this as type 1 error (α) =0.001, and allowable error of 5% the estimated sample size is calculated as follows-

Formula for sample size-

$$(n)= \frac{(Z^{\alpha}/_{2}+Z^{\beta}/_{2})2/2\times(SD)2}{(m1-m2)2}$$

Where,

n= sample size

Z=level of significance

SD=$\frac{SD1+SD2}{2}$ =10.76

m1-m2=12.46

n= 36

so, the total sample size will be 36

Group A (Rice mill workers) & Group B(Controls), so 36 in each group Spirometric parameters will be compared in two groups
For all the participants, participant information sheet was distributed. A questionnaire [14,15] which was mainly for respiratory symptoms was also distributed that also included demographic details of the participants like age, gender, etc.

Inclusion Criteria:

- All the rice mill workers in the age limit of 20-50 years and who were permanent workers, those who gave their consent voluntarily.

- For controls, all the apparently healthy, age and sex matched individuals and consented to participate in the study.

Exclusion Criteria:

- The subjects with- History of recent respiratory illness like pneumonia, tuberculosis as well as old pulmonary tuberculosis.
- Obesity (BMI>32kg/m2)
- Any history of recent eye surgery or abdominal or thoracic surgery.
- Chest or spinal deformity
- Family history of asthma.

Procedure: Each participant was interviewed and questionnaire was filled by trained interviewer. Brief history and Clinical examination were done. Height was measured using a Stadiometer and weight by standard weighing scale. Spirometry was performed by the trained technician on all the study subjects using the instrument Spiro lab Roma Italy in sitting position. Before doing the spirometry, it was ensured that all the instructions as mentioned in the participant information sheet, regarding preparation of the participant for the test were met. In order to perform the test, they were asked to take deep breath followed by forceful expiration into the disposable mouth piece of the instrument in sitting position. Accurate results were obtained only when the mouth piece was inserted without leak of air or obstruction by the lips or the teeth and forced expiration was completed without any pause or leak of air around the mouth piece. The subjects were then be asked to inspire rapidly again to maximum capacity with nose closed. The lung volumes and capacities (FVC, FEV1, PEFR, and FEV1/FVC ratio) were obtained by repeating the procedure 3 times and the best of the three values were taken. The spirometry instrument Spirolab Italy is according to American Thoracis Society (ATS) standards. [16] Airflow limitation seen in COPD patients is defined as a post-bronchodilator FEV in 1s (FEV1) to FVC (forced vital capacity) ratio <0.70, without reversibility to bronchodilators. The severity of airflow limitation in COPD is classified based on Global Initiative for Obstructive Lung Disease (GOLD) criteria.

The cases of COPD were grouped in accordance with these GOLD criteria:

• Group 1: Mild – FEV1 ≥ 80%

• Group 2: Moderate – 50% ≤ FEV1 < 80%

• Group 3: Severe – 30% ≤ FEV1 < 50%. Respiratory symptoms are defined as [5]

1. Chest tightness: tightness or constriction of the chest occurring any time during the work shift and on any workday, without being worse.

2. Dyspnoea: Having to walk slower than a person of the same age at an ordinary pace on level ground because of breathlessness

3. Chronic Cough: Cough without sputum occurring on most 5 days a week for minimum of 3 months a year for at least two consecutive years.

4. Chronic Phlegm: Sputum production occurring on most 5 days a week for minimum 3 months a year for at least two consecutive years. The Respiratory Symptoms Questionnaire (1986) approved by Medical Council's committee on Environmental and Occupational Health was administered. [17,18]

Statistical Analysis:

SPSS software was used to carry out the statistical analysis. After the data collection, unpaired t-test was used to compare mean values of FVC, FEV1 & FEV1/FVC ratio between the study groups, A p-value of less than 0.05 was considered statistically significant for this study. Descriptive statistics was done for comparison of the anthropometric parameters and baseline haemodynamic parameters. Duration of work, type of work done and Respiratory symptoms in subject group was expressed in proportions.

Results

Our study included 36 subject group (rice mill workers) and equal number of age and sex matched controls. All the participants in the study were males. The results were expressed as the mean ± standard deviation (SD). The Anthropometric parameters and baseline hemodynamic parameters of the subject group compared with control group is shown in Tables 1.

Table 1: Mean values of the Anthropometric parameters and baseline hemodynamic parameters of the study group compared with control group

Study Parameters	Subject Group Mean ±SD (n=36)	Control Group Mean ±SD (n=36)	Mean ±SE of Difference	95% CI of Difference		t-Statistic	p-value
				Lower Bound	Upper Bound		
Age (in years)	37.5±8.4	36.4±8.5	1.1±2	-2.86	5.08	0.558	0.578
Weight (in kg)	67.9±8.7	68.3±8.9	-0.4±2.1	-4.51	3.73	-0.188	0.851
Height (in mts)	1.6±0.1	1.7±0.1	0±0	-0.05	0.02	-0.895	0.374
BMI (in kg/mts. Sq.)	25±2.4	24.7±2.9	0.2±0.6	-1.02	1.50	0.382	0.704

systolic blood pressure mmhg)	119.4±6.2	118.8±5.8	0.6±1.4	-2.21	3.43	0.432	0.667
diastolic blood pressure mmhg)	75.8±5.5	75.6±6.2	0.2±1.4	-2.56	2.95	0.141	0.888
Pulse(beats/min)	76.8±4.9	77±5.2	-0.2±1.2	-2.53	2.20	-0.140	0.889

There was no significant difference seen in Age, Anthropometric parameters (Weight, Height and BMI) and baseline hemodynamic parameters (systolic blood pressure, diastolic blood pressure and pulse) between the two groups. The spirometry parameters of the subject group compared with control group are shown in Tables 2.

Table 2: Comparison of mean values of spirometry parameters between the subject group and control group

Spirometry Parameters							
Study Parameters	**Subject Group Mean ± SD (n=36)**	**Control Group Mean ±SD. (n=36)**	**Mean ±SE of Difference**	**95% CI of Difference lower bound**	**upper bound**	**t-Statistic**	**p-value**
FVC	2.7±1	3.6±0.6	-0.9±0.2	-1.31	-0.51	-4.573	<0.0001*
FEV1	1.7±0.7	3±0.5	-1.3±0.1	-1.54	-0.98	-8.847	<0.0001*
FEV1/FVC Ratio	64.1±5.6	83.1±4.8	-19±1.2	-21.48	-16.54	-15.355	<0.0001*

The mean FVC in subject group was 2.7±1 while that in controls and control group was 3.6±0.6. The mean FEV1 in subject group was 1.7±0.7 while that in controls was 3±0.5. The mean FEV1/FVC in subject group was 64.1±5.6, while that in controls was 83.1±4.8. There was highly significant difference seen above mentioned spirometry parameters between the two groups with p value (< 0.0001). The table 3 shows the distribution of rice mill workers according to duration of exposure in years and type of work done by the subject group in rice mill.

In the subject group the prevalence of respiratory symptoms reported by the rice mill workers is shown in Table 3.

Table 3: Duration of exposure, type of work done and respiratory symptoms in rice mill workers (n=36)

Study Parameters	**n (%)**
Duration of exposure in rice mill (in years)	
< 5	8 (22.2%)
11-15	14 (38.9%)
5-10	14 (38.9%)
Type of Work done	
Load	24 (66.7%)
Destone	10 (27.8%)
Dehusk	12 (33.3%)
Pour	28 (77.8%)
Respiratory Symptoms	
Chest Tightness	23 (63.9%)
Cough	20 (55.6%)
Cough with Phelgm	19 (52.8%)
Shortness of Breath	6 (16.7%)

Our other observations regarding the subject group [n(% value)] are the duration of exposure less than 5 years 8 (22.2%), 5-10 years 14 (38.9%), and 11-15 years 14 (38.9%). The type of work done by the subject group was load 24 (66.7%), destone 10 (27.8%), de-husk 12 (33.3%) and pour 28 (77.8%). They showed some respiratory symptoms like chest tightness 23 (63.9%), cough 20 (55.6%), cough with phlegm 19 (52.8%) and shortness of breath 6 (16.7%).

Post-bronchodilator test was performed on the subjects who showed a FEV1/FVC ratio of less than 70%. After bronchodilatation, there was a significant change i.e. more than 12 % from the baseline and this was most likely suggested bronchial asthma, which suggests an allergic tendency to silica husk. In the study group, 17% showed COPD.

Discussion

Pneumoconiosis are occupational lung diseases that are caused due to a person inhaling harmful substances at his or her workplace to accumulation of dust in the lungs and body's reaction to its presence. Most common pneumoconiosis are

silicosis, coal workers' pneumoconiosis (CWP), and asbestosis. Such diseases are preventable or controllable. Assessing the risk of occupational morbidity helps in identifying appropriate measures for prevention and control. Rice mill dust contains husk and may contain a large number of contaminants including silica, fungi. Therefore, the workers are at high risk of inhaling such contaminants. [19,20] Our present cross-sectional study was conducted among 36 rice mill workers; with the mean age 37.5± 8.4 years all were males and spirometry parameters were compared with 36 healthy volunteers the mean age 36.4± 8.5 years.

All belonged to low socio-economic status and also with lower education status. The spirometry parameters in our study revealed significantly ($p < 0.0001$) lower levels of FVC, FEV1, FEV1/FVC. [21] Thus, the present study confirms the findings of other studies and suggests that rice husk dust adversely affects lung function parameters with changes suggestive of an obstructive pattern of lung disease. This may be associated with years of exposure to husk dust. The present study, showed mild to moderate obstructive lung disease pattern which can be attributed to fact that all the workers were using cloth mask to cover but proper protective masks were not being used. Also, the duration of exposure most of the workers was less than 5 years. There is a significantly higher prevalence of respiratory symptoms such as chest tightness, cough, phlegm, and shortness of breath was seen in individuals working for 10 -15 years duration. The respiratory symptoms such as tightness of chest, cough and phlegm may be allergic responses, either to a protein constituent of the rice husk or to some microbiological contaminant due to dust exposure during milling, transfer operations, mixing processes. [19,20] Chronic respiratory symptoms, suggest that exposure dust may lead to chronic bronchitis. Post bronchodilator test was performed on the subjects who showed a FEV1/FVC ratio of less than 70%. After bronchodilatation, there was a significant change i.e. more than 12 % from the baseline and this was most likely suggested bronchial asthma, which suggests an allergic tendency to silica husk. Our study findings are similar to studies carried out by Ghosh et al [5] that showed that workers exposed to dust were having significant lower level of FVC, FEV1, and PEFR parameters compared to control in Karnataka. High prevalence of respiratory morbidity (34%) was found among rice mill workers of Bangladesh by Ansari et al. [21] Studies by Koteswaramma et al. [22] found significantly higher prevalence of respiratory morbidity among rice mill workers (74%) than control (26%) and respiratory morbidity was proportionately increasing with the duration of dust exposure. Respiratory symptoms were more in workers involved in sweeping and milling inside mill. All the findings of our study are important as they indicate the need for preventive measures in the study group. The rice mill workers need to include technical preventive measures, such as ventilated work areas and wearing appropriate respiratory protective devices. These measures will help in preventing lung damage, which subsequently contributes to morbidity and mortality. It is also suggested that rice mill workers must undergo periodic medical tests. These tests will identify susceptible workers, so that they can take adequate preventive measures as well as treatment. The strength of the study was that direct interview and physical examination was done by which prevalence of respiratory morbidity among these individuals was possible to be detected and spirometry findings confirmed the same. The population in question were directly benefited by this study at large and awareness about lung health was spread among them.

Limitations:

The limitations of our study are, small sample size. Larger sample size would be required to estimate the pattern of lung disease whether obstructive or restrictive, and also to asses severity according to mild, moderate and severe. Detailed study with large samples size needs to be done to study association between the spirometry parameters with number of years of employment in this industry, type work carried out in the mills and the respiratory symptoms. Further studies involving haematological and radiological studies should be done in the study group to confirm the allergic responses.

Conclusions

Our study concludes allergic tendency to silica husk was predominant among majority of rice mill workers of this area in Western part of Maharashtra where the study was conducted. Although the workers were using some kind of protection such as covering up with cloth, it is recommended that using proper mask like N95 mask and taking other personal protective measures are important for preventing further damage that may help improving lung health. This can be done by spreading awareness regarding the same and periodic screening of these individuals. Spirometry is an important tool that can be used for this purpose. Also, periodic health check-ups need to be arranged for these rice mill workers. Health check-up before joining the work, periodic physical examination, and health educational activities may be implemented. Primary treatment, necessary advice, and health education were provided mainly to workers who had any respiratory morbidity.

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