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Risk factors associated with respiratory morbidity among puffed rice workers in an urban area of Davanagere city

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Abstract
Introduction: Occupational respiratory disease can be defined as an acute or chronic disorder that arises from the inhalation of air-borne agents in the work place. Puffed rice is a famous food item in Karnataka, which is produced in a cluster of small units.
Materials and Methods: A Cross sectional study was conducted among puffed rice workers in Bashanagar, urban field practice area of SSIMS & RC, Davanagere. From January to December 2017. The study population included 550 puffed rice unit workers.
Results: The prevalence of respiratory morbidity among the puffed rice workers in the present study was found to be 41.0%. Among them 51(9.2%) puffed rice workers reported Obstructive lung diseases and majority of the workers 175(31.8%) reported Restrictive pattern of lung diseases.
Conclusion: The risk of Respiratory morbidity was significantly associated with Age, **g**ender, Education, duration of the work and type of work.

Keywords: Respiratory morbidity, puffed rice workers, spirometry

1. Introduction
Occupational respiratory disease can be defined as an acute or chronic disorder that arises from the inhalation of air-borne agents in the work place. Subjects with workplace exposure to organic dust have high prevalence of respiratory diseases[1]. Many industrial processes produce air-borne contaminants and the most common route of absorption is by inhalation.[2] Puffed rice is a popular food item, which is produced in cluster of small units often located in urban centers. Among various states in India, Karnataka has some of the largest number of clusters of Puffed Rice units. Major clusters are in the towns of Karnataka like Davanagere, Hubli, Dharwad and Belgaum. Davangere is the largest supplier of puffed rice not only to other districts of Karnataka but also to other states. The fuels used in ovens are mainly rice husk, wood shavings, groundnut shell and automobile tyres as they generate high heat and are of low cost. Subjects with workplace exposure to organic dust have high risk of prevalence of respiratory diseases. Industrial dust inhalation over a long period of time leads to proliferative and fibrotic changes in the lungs[3]. A large number of studies have been undertaken to assess the effect of dust on lung functions in various occupations[4]. But very few studies have been carried out among the workers engaged in puffed rice production. Due to limited availability of literature on the same, this study was taken up in order to assess the magnitude and pattern of respiratory morbidity and factors associated with it among puffed rice workers in urban field practice area of SSIMS & RC, Davanagere.

2. Material and Methods
A cross sectional study was conducted during January to December 2017 among the workers of puffed rice units situated at Bashanagar, Urban field practice area of SSIMS&RC, Davanagere. Ethical clearance was obtained from the Institutional Ethical Review Board. The workers working in these units aged >14 years, Workers working for >1 year and Workers willing to participate included in the study. Pregnant women, Those who have undergone cardiothoracic surgery and Recent history of Myocardial infarction were excluded from the study (As Spirometry can not be performed among the above mentioned subjects).

A study by Energy Research Institute among the puffed rice production workers in Davangere showed that the respiratory morbidity was 15.6%.9
Hence n= Where p= prevalence of respiratory morbidity 15.6%
q= 100-p= 84.4
d= 20% of p = 3.12

$$\text{Hence } n=\frac{4 \text{ x} 15.6\text{x} 84.4}{3.12\text{x} 3.12}=541, \text{N}=541, \text{rounded for } 550.$$

In order to collect data from 550 workers, out of 1200 puffed rice production units situated in Bashanagar, 550 production units were selected by using simple random sampling method using random number table. From each unit only one worker was taken randomly by lottery method. A pretested semi structured and validated questionnaire were used to collect information from each worker after taking informed consent. The questionnaire contained information on socio demographic details of the worker which includes the type of family, income, education and socio economic status. The questions for smoking, Alcohol, Family History, respiratory morbidity assessment, occupational and exposure history were taken from American Thoracic society (ATS) [5]. The wheezing/Asthma questions were adapted from International Union against Tuberculosis and Lung disease (IUATLD) Bronchial questionnaire [6]. Height measurement in centimeters was done in erect standing position using non stretchable measuring tape and Weight was measured in kilogram (Kg) using standardized bathroom weighing machine. Body mass index (BMI) Classification proposed by the WHO Western Pacific Regional office in Collaboration with IOTF (International obesity Task Force steering committee (2000) for Asian population was used[7]. Spirometry was carried out by the instrument RMS (Helios's) Spirometer. The following parameters were used in the spirometry.
Forced vital capacity (FVC), Forced expiratory volume in one second (FEV1), FEV1/FVC ratio, PEFR (Peak expiratory flow rate) and Mean forced expiratory flow between 25% and 75% of FVC (FEF 25-75%).
Any person with spirometer reading showing FEV1 <80% of the predicted normal for age and sex, FVC usually reduced but to a lesser extent than FEV1 and FEV1/FVC ratio reduced to <0.7 were considered to have Obstructive pulmonary disease and spirometer showing FEV1 <80% of the predicted normal, FVC <80% of the predicted normal and FEV1/FVC ratio being normal (i.e. >0.7) were diagnosed to have Restrictive pulmonary disease [8]. If the spirometer reading showing FEF (25-75%) >65% of the predicted for age and sex is considered as normal. If FEF (25-75%) is <65% is considered as decreased [8]. The spirometer reading showing PEFR >80% of the predicted for age and gender is considered as normal. Spirometer reading showing PEFR (50-80%) considered as moderate flow rate and PEFR (< 50%) it is predicted as respiratory defect [9].

2.1. Statistical analysis
Data was entered in MS EXCEL, statistical analysis was done using SPSS version 20 and results were expressed in terms of percentages and proportions. Chi square test was applied to find out the association between respiratory morbidity and factor associated with it. ANOVA test was used to determine the lung function values of the puffed rice workers according to the duration of exposure. A statistical significance of $P \leq 0.05$ was considered.

3. Results
In the study based on spirometry the prevalence of respiratory morbidity was (41.0%). 51(9.2%) of the puffed rice workers were reported obstructive lung disease and majority of the workers 175(31.8%) were reported restrictive pattern of lung diseases. Among obstructive diseases majority of the workers showed moderate obstructive pattern 19(38%). In restrictive pattern of lung diseases majority of the workers were showed moderate restrictive pattern 77(44%). These are explained in the Table 1.

Table 1: Distribution of study participants based on Pattern of Respiratory Morbidity.

Variables	Frequency	Percentages
Normal lung function	324	59.0
Obstructive	51	9.0
Restrictive	175	32.0
Total	550	100
Grading of obstructive based on FEV1 Ratio		
Mild obstruction	8	16.0
Moderate	19	38.0
Moderately severe	13	26.0
Severe	9	18.0
Very severe	2	4.0
Grading of restrictive disease based on FVC Ratio		
Mild restriction	26	15.0
Moderate restriction	77	44.0
Moderately severe	45	26.0
Severe	23	13.0
Very severe	4	2.0

In this study Majority of the workers were males, between the age group of 31-40 years and illiterates which were significantly associated with respiratory morbidity. Majority of the workers residing at nuclear family and belongs to class III Socioeconomic state but no statistically significant association was found with respiratory morbidity. The association of Respiratory morbidity with socio-demographic factors are explained in the Table 2.

Table 2: Association of socio-demographic features with respiratory morbidity

Variables	Spirometry pattern			Total	χ2 Value	Df	P value
Sex wise distribution	**Normal**	**Obstructive**	**Restrictive**				
Male	295(59.8%)	39(7.9%)	159(32.3%)	493(100.0)	10.493	2	0.04
Females	29(50.9%)	12(21.1%)	16(29.1%)	57(100.0)			
Age wise distribution							
<20	21(44.6%)	3(6.3%)	23(48.9%)	47(100.0)	58.1	1	0.000
21-30	96(64.4%)	13(8.7%)	40(26.8%)	149(100.0)			
31-40	106(67.9%)	3(6.3%)	47(31.3%)	156(100.0)			
41-50	64(60.3%)	10(9.4%)	32(30.1%)	106(100.0)			
51-60	20(29.8%)	18(26.8%)	29(43.2%)	67(100.0)			
>60	17(68.0%)	4(16.0%)	4(16.0%)	25(100.0)			
Type of family					1.2	4	0.760
Joint	82(58.6%)	13(9.3%)	45(32.1%)	140(100.0)			
Nuclear	233(58.5%)	38(9.5%)	127(31.9%)	398(100.0)			
Three generation	9(75.0%)	0	3(25.0%)	12(100.0)			
Education							
Illiterate	89(54.9%)	21(12.9%)	52((32%)	162(100.0)	21.25	1	0.019
Primary	65(66.3%)	12(12.2%)	21(21.4%)	98(100.0)			
Middle	66((50.7%)	11(8.4%)	53((40.7%)	130(100.0)			
High school	64(65.9%)	3((3.0%)	30(30.9%)	97(100.0)			
PUC/diploma	23(57.5%)	2(5.0%)	15(37.5%)	40(100.0)			
Undergraduate/Postgraduate	17(73.9%)	2(8.6%)	4(13.7%)	23(100.0)			
Socioeconomic status according to Modified B G Prasad classification							
Class III	32(64.0)	3(6.0%)	15(30.0%)	50(100.0)	1.96	6	0.923
Class IV	273(58.3)	46(9.8%)	149(31.9%)	468(100.0)			
Class V	19(59.4)	2(6.0)	11(34.6)	32(100.0)			
Total	324(59.0%)	51(9.2%)	175(31.5%)	550(100.0)			

In this study majority of the workers were Non –smokers but no significant association was found between smoking and respiratory morbidity. In this study duration of the work of the majority of the workers was 11-20 years and it is significantly associated with respiratory morbidity. Majority of the workers work for< 9 hr/day but no significant association was found. Majority of the workers belonging to process of salt mixing which is significantly associated with respiratory morbidity. In this study Respiratory morbidity was higher among non-users of personal protective equipmentbut no statistical significant association was found between personal protective equipment and respiratory morbidity.

Association of Respiratory morbidity with these risk factors is explained in Table 3.

Table 3: Association of risk factors with respiratory morbidity

Variables	Spirometry pattern			Total	χ2 Value	Df	P value
Smoking history	Normal	Obstructive	Restrictive				
Smokers	156(57.99)	30(11.15)	83(31.32%)	269(100.0)	2.235	2	0.327
Non smokers	168(59.7%)	21(7.4%)	92(32.74%)	281(100.0)			
Duration of work in years							
<5 years	47(45.4%)	2(2.5%)	28(36.36)	77(100.0)	34.63	6	0.000
5-10 years	81(75.7%)	3(2.8%)	23(21.49)	107(100.0)			
11-20 years	126(58%)	19(8.7%)	72(33.1%)	217(100.0)			
>20 years	70(46.9%)	27(18.1%)	52(34.8%)	149(100.0)			
Duration in hours/day							
<9 hours	269(59.8)	46(10.2%)	135(30.0%)	450(100.0)	5.29	2	0.07
>9 Hours	55(55.0%)	5(5.0%)	40(40.0%)	100(100.0)			
Type of work							
Puffing	58(65.9%)	7(7.9%)	23(26.1%)	88(100.0)	21.5	12	0.043
Salt mixing	65(46.7%)	20(14.3%)	54(38.8%)	139(100.0)			
Water filling	47(71.2%)	6(9.0%)	13(19.6%)	66(100.0)			
Soaking	32(66.6%)	3(6.2%)	13(27.0%)	48(100.0)			
Paddy boiling	38(66.6%)	2(3.5%)	17(29.8%)	57(100.0)			
Rice drying	55(55%)	9(9.0%)	36(36.0%)	100(100.0)			
Carrying rice for dehusking	29(55.7%)	4(7.6%)	19(36.5%)	52(100.0)			
Personal protective equipments							
Users	18(50.0%)	3(8.3%)	15(42.0%)	36(100.0)	1.73	2	0.421
Non users	306(60.0%	48(9.3%)	160(31.1%)	514(100%)			
Total	324(59.0)	51(9.2%)	175(31.8%)	550(100.)			

In present study mean parameters of spirometry i.e. mean FVC, FEV1, FEV1/FVC ratio, PEFR and FEF 25-75% were decreased with increase in the duration of work. ANOVA test showed that significant difference was found between parameters of spirometry with increases in duration of work. P value (<0.05) considered as statistically significant. The comparison of parameters of spirometry with respect to duration of work are explained in Table 4.

Table 4: Comparison of Parameters of Spirometry with relation to duration of employment of puffed rice workers.

Variables	Mean	Standard deviation	F value	P value
FVC				
<5 years	2.66	0.62	13.25	0.000
5-10 years	2.72	0.58		
11-20 years	2.48	0.61		
>20 years	2.26	0.66		
FEV1				
<5 years	2.41	0.64	3.03	0.029
5-10 years	3.46	9.58		
11-20 years	2.21	0.63		
>20 years	1.90	0.65		
FEV1/FVC Ratio				
<5 years	94.79	8.03	16.14	0.000
5-10 years	95.54	8.40		
11-20 years	92.86	10.75		
>20 years	87.14	13.24		
PFFR				
<5 years	6.31	1.95	15.21	0.000
5-10 years	6.78	1.83		
11-20 years	5.97	1.47		
>20 years	5.37	1.75		
FEF 25-75%				
<5 years	3.45	1.26	23.79	0.000
5-10 years	3.56	1.18		
11-20 years	3.04	0.92		
>20 years	2.56	0.91		

4. Discussion

The present study was conducted among workers employed in puffed rice units which are located in Bashanagar, urban field practice area of SSIMS &RC, Davanagere. In this study majority of the workers were males (89.64%). significant association was found the between age group and respiratory morbidity. The results were in line with similar study conducted by Rana MC *et al.* [10]. Present study showed significant association between respiratory morbidity and sex distribution. The present study results were comparable with results seen in study conducted by Naik PR *et al.* [11]. Present study showed that significant association was found between education of the workers and respiratory morbidity. In contrast to this a study done by Rana MC *et al.* [10]. showed that no significant association was found between education and respiratory morbidity.

In this study majority of workers were Non-smokers 281(51%) and no significantly association was found between smoking and Respiratory morbidity. Similar result was reported from study done by Ratnaprabha GK *et al.* [4] and Ajeel NAH *et al.* [13] In contrast to this a study done by Ghosh T *et al.* [12], Ijadonola KT *et al.* [15], Pour ARL *et al.* [14] Although the majority of workers in these studies were nonsmokers but significant association was found between smoking and respiratory morbidity. In contrast to this study done by Rana MC *et al.* [10], Eshwaramma P *et al.* [16] where majority of the workers were smokers and significant association was found between respiratory morbidity and smoking status. In the present study, significant association was found between the respiratory morbidity and duration of work. Similar result was found by study done by Prakash S *et al.* [17], Rana MC *et al.*10 and Ajeel NAH *et al.* [13]

In present study the respiratory morbidity was more among the workers who work less than 9 hrs per day but no significant association was found. In contrast to this study done by Rana MC *et al.* [10] showed that significant association was found between respiratory morbidity and number of working hours/day.

In this study Majority of the workers did not use any form of personal protective equipment and respiratory morbidity was higher among non-users of personally protective equipment but no statistical significant association was found. Similar results were found from study done by Ratnaprabha GK *et al.* [4] In contrast in a study done by Rana MC *et al.* [10] showed that significant association was found between personal protective equipment and respiratory morbidity.

In present study prevalence of respiratory morbidity among puffed rice workers was 41.0%. Among them 51(9.2%) puffed rice workers reported obstructive lung diseases and majority of the workers 175(31.8%) reported restrictive pattern of lung diseases. Similar results were found by A case study done by the Energy Research Institute, Bangalore at Davanagere city [3] which Showed that majority of the workers were reported restrictive pattern of lung diseases and Tawade PM *et al.* [18] In contrast to this study a study done by Rana MC *et al.* [10], Ghosh T *et al.* [12] showed that majority of the workers in their study were reported obstructive pattern of respiratory diseases.

In this study the parameters of spirometry i.e. mean FVC, FEV1, FEV1/FVC ratio, PEFR and FEF25-75% were significantly reduced. Significant difference was found between the parameters of spirometry and increase in the duration of work among puffed rice workers. Which is in

line similar with other studies conducted by Rana MC *et al*. [10] and Ghosh T *et al.* [12]. Decrease in FVC may be due to changes in the bronchi and elastic component of lungs resulting in restrictive type of lung impairement.[19] FEV1 due to exposure to dust causes early obstructive pulmonary impairment which further increases with increase in number of years of exposure [20]. Decreased in PEFR values which indicate the larger airway obstruction and decrease in FEF25-75% is a measure of small airway obstruction [21]. The limitations of the present study are, the etiologic diagnosis of respiratory morbidity was not possible by spirometry alone. Chest X ray and other investigation would have been required for further confirmation. As interview schedule was the primary data collection tool, which required recall of information regarding the exposure, illnesses and PPE usage, the possibility of recall bias exists and healthy worker bias could be another limitation since those who were severely ill could have died or left the job or shifted to other sections.

5. Conclusion

The risk factors for respiratory morbidity which were significantly associated with age, sex, education, cross ventilation, duration of work and type of work. In this study parameters of spirometry i.e. mean FVC, FEV1, FEV1/FVC ratio, PEFR and FEF 25-75% were significantly reduced. The parameters of spirometry were decreased as the increase in the duration of the work which can be explained by dose response relationship.

Recommendations

1. To initiate provision and promotion of personal protective equipment (such as respiratory mask) to all who were involved in puffed rice units.
2. Clean the floor of the puffed rice units only after wetting it, otherwise dust will spread in the air and increases the risk of exposure to rice dust in many folds.
3. Pre-placement examination should done before workers joining the puffed rice units.
4. Regular periodic medical examination required for the workers of the puffed rice unit.
5. Health education for the puffed rice workers must be done about the dangers of rice dust exposure, occupational lung diseases and other occupational hazards and use of personal protective equipment's for protection from hazards.

6. Acknowledgement

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