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Prevalence and factors associated with lung function abnormalities among rice mill workers in Sokoto state, Northwest Nigeria

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ABSTRACT

Introduction: Northwest Nigeria has witnessed an increase in rice milling activities due to the ban on rice importation. The majority of workers in the industry, as it is in many informal sectors workers are disproportionately affected by hazards in the workplace due to poor usage of protective devices. Inhalation of dust over a long period results in lung function abnormalities. The study assessed the prevalence and factors associated with lung function abnormalities among rice mill workers in Sokoto state, Northwest Nigeria.

Methods: The study was conducted using a cross-sectional design. The study population was made up of workers who were at least 18 years old and had worked for at least one year in the rice mills Data were collected between June 2019 and July 2019 using an interviewer-administered questionnaire and a lung function examination was conducted using a calibrated Contec SP10 digital spirometer following standardized procedures. Data were analyzed using IBM SPSS version 23 and presented in tables and charts.

Results: About a third of 119 (30.2%) of the respondents had abnormalities on spirometry, and there was a statistically significant reduction in the mean FVC (3.63 ± 0.39) and FEV_1 (3.01 ± 0.36). Being at least 30 years of age (aOR=3.3), working more than 8 hours a day (aOR=2.4), and having at least a symptom of respiratory morbidity (aOR=10.1) were the factors found to be significantly associated with lung function abnormalities.

Conclusion: This study showed that the prevalence of lung function abnormality among rice mill workers in Sokoto state is relatively high and age, number of hours worked per day and having at least a symptom of respiratory morbidity were the factors associated with lung function abnormalities.

Key words: Spirometry, Respiratory Health, Rice mill workers, Lung function tests

Introduction

Globally, about 2.9 billion workers are unprotected from hazardous risks at their workplaces.[1] These hazards result in diseases and deaths with an estimated 2.8 million such deaths believed to have occurred in 2017 alone.[2] Majority of these deaths occur in Low and Middle-Income Countries including Nigeria despite being low on the ladder of industrialization. The high prevalence of work-related diseases and death among workers in Nigeria can be attributed to the increasing number of factories with unacceptable health and safety practices.[3] Workers in the informal sector are disproportionately affected by this problem because most of them operate outside the radar of the regulatory authorities saddled with the responsibility of ensuring the safety of the work environment. Workers in the grain industry are no exception to this. The large volume of dust generated in the grain processing

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industry constitutes a major problem for the respiratory health of workers in the industry. Occupational respiratory disease has been described as an acute or chronic disorder arising from the inhalation of airborne agents in the workplace.[4] Dust generated during the production process of grains has been of concern in the industry because of its long-term effects on workers' respiratory health. Harmful dust exposures in the workplace impact workers' health negatively due to the deposition of dust particles in their lungs.[5]

Workers in rice mills are exposed to organic and inorganic dust high in particulate matter (PM) 2.5 and 10.[6,7] Also, rice husk is high in silica and may cause bronchogenic carcinoma, and pulmonary diseases resembling asbestosis.[6] Rice dust causes damage to bronchial passages along with damage to the elastic component of alveolar walls as a result of inflammatory reactions of the tissues, and eosinophilia.[8,9] These distinctive clinical changes, in addition to hematological, and radiological findings among rice mill workers have been described as "Rice Millers' Syndrome".[9]

Lung function tests have long been used in the screening and diagnosis of lung disorders. Spirometric pulmonary function tests can detect lung dysfunction before clinical symptoms appear.[10] The respiratory functions of grain workers (including rice mill workers) become impaired over time compared to that of the healthy population with decreased Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV_1), and Peak expiratory Flow Rate (PEFR).[11, 12] Available evidence suggests similarities in lung function studies abnormalities seen among rice mill workers and those seen among workers exposed to dust from other sources.[13-15] Respiratory system diseases induced by occupational dust are influenced by the type of dust and duration of exposure. Also, the spirometric parameters have shown declines related to the duration of exposure.[16,17] Despite available policies and guidelines aimed at safeguarding workers' health in their workplace, studies have shown that rice mill workers still suffer significant harm in the course of work.[4, 8, 11, 18, 19] In one of such studies carried out among rice mill workers in India, 36.6% and 35.1% of the workers had obstructive and restrictive pulmonary diseases respectively, and these were characterized by significant declines in the spirometric parameters (FVC, FEV_1, FEV_1/FVC,).[4] Similar findings have been reported in other studies including Nigeria.[6, 18, 20] The factors that have been identified to be associated with abnormalities on spirometry include age, duration of work experience, number of hours worked per day, and the use of personal protective equipment(PPE).[8, 19, 21]

Lately, Nigeria has witnessed an increase in the local production of rice largely due to the government ban on imported rice.[22] The consequence of this is that more people are now involved in rice milling than before with non-existent OHS infrastructure. Also, not much has been done among this occupational group, especially in North-western states including Sokoto state which is fast becoming a hub for local rice production. This study, therefore, is aimed at determining the prevalence and factors associated with lung function abnormalities among rice mill workers in Sokoto state, Northwest Nigeria. This we believe will help raise awareness among stakeholders in the industry and guide policies and programs towards improving OHS practices among this occupational group and others in similar occupations.

Methods

The study was a cross-sectional study conducted in Sokoto state Nigeria between June 2019 and July 2019. The study is part of a large study assessing Hazards, work-related morbidities, and safety practices among rice mill workers in Sokoto state. Sokoto is one of the states in Northwest Nigeria and is fast becoming a hub for rice milling. The agrarian rural communities in the state are largely responsible for the production of paddy rice that feeds the rice mills, however, the state receives supplies from the neighboring states. The study population was made up of workers who were at least 18 years old and had worked for at least one year in the rice mills, while those that were not fully involved in rice milling activities, and administrative staff were excluded from the study. The sample size and sampling method employed in the study have been described in a previously published article on the determinants of respiratory symptoms among rice mill workers in Sokoto state.[23]

Data were collected using a pretested interviewer-administered questionnaire, and a lung function test was carried out using a Contec SP10 handheld digital spirometer. The spirometer was calibrated daily before use with a 3-liter calibration syringe. The participants were told to avoid alcoholic drinks on the day of the examination, and not to smoke one hour before the test. Also, they were told to take a light meal and not to wear tight clothing.[24] The participants were made to be in a standing position, with the chin elevated and the neck slightly extended. A nose clip was applied to keep

both nostrils closed, and a breathing mask was placed around the mouth. Participants were asked to take a deep breath in, hold their breath for a few seconds, and then exhale as hard as possible into the mask. This process was repeated until an individual achieved three acceptable readings, without exceeding eight attempts. Acceptable spirograms were those that meet the American thoracic society/European respiratory society criteria and the largest 2 values for both FVC and FEV_1 within 150mls of each other.[25] The highest value from three close test readings was used for FVC and FEV_1.[25] The online global lung function initiative 2012(GLI-2012) was used in calculating the predicted FVC, FEV_1/FVC, and FEV_1. Participants with FEV_1/FVC values equal to or greater than 70%, FEV_1, and FVC each equal to or above 80% of predicted were classified as normal. Participants with FEV_1/FVC below 70% were classified as having obstructive pulmonary disease, while those with FEV_1/FVC equal to or greater than 70%, FEV_1, and FVC below 80% of predicted were classified as having a restrictive pulmonary disease.[26] Participants with obstructive and restrictive pulmonary diseases will be categorized as having an abnormal lung function test.

Data analysis was done using IBM® SPSSversion 23. A Chi-square test was performed to assess the association between independent sociodemographic/work profile variables and the presence/absence of abnormality on spirometry. The means of spirometric parameters and that of predicted were compared using the one-sample *t*-test, while the independent *t*-test and one-way ANOVA tests with Tukey-HSD post-hoc analysis were used to compare the means of spirometry parameters between various categories of the sociodemographic/work profile variables. The level of significance (α) was set at <0.05 at 95%CI.

Ethical approval was obtained from the Ethics Committee of Usmanu Danfodiyo University Teaching Hospital, Sokoto.

RESULTS

A total of 394 respondents completed the study giving a response rate of 99%

Sociodemographic characteristics of the respondents

The sociodemographic characteristics of the respondents had been described previously.23 The mean age was 26.2 ± 7.5years. The majority of the respondents, 235(59.0%) were between 20 and 29 years of age, while 31(7.8%) of them were above 40years of age. Only a handful of 4 (1.0%) of the workers had tertiary education. Only 63(15.8%) of the 398 respondents smoked cigarettes, and 297 (74.6%) had worked for less than 10 years

Comparison of actual and predicted mean values of lung function test of respondents

Table 1 shows that the mean FVC of 3.63litres ± 0.39 among the respondents was significantly lower ($p<0.05$) than the mean for predicted, while the FEV_1 of 3.01 ± 0.36 liters among the respondents was significantly lower ($p<0.05$) than the mean for predicted. Also, the mean FEV_1: FVC ratio among respondents was 0.83 ± 0.06, and this was significantly lower ($p<0.05$) than the mean for the predicted FEV_1: FVC ratio.

Lung function abnormalities of respondents

Figure 1 shows that 119 (30.2%) of the respondents had abnormalities on spirometry, out of which 23 (19.3%) had an obstructive pulmonary disease and 96 (80.7%) had restrictive pulmonary disease.

Association between respondents' socio-demographic characteristics and lung function abnormalities

Table 2 shows that respondents' age, marital status, smoking status, length of working experience, hours worked per day, job description, and having at least one symptom of respiratory morbidity are the factors significantly associated with abnormalities on spirometry. The proportion of respondents with lung function abnormalities was significantly higher ($p = 0.001$) among those aged 30yrs and above (43.1%) as compared to those below 30yrs (25.3%). Also, the proportion of respondents with lung function abnormalities was greater among cigarette smokers as compared to non-smokers ($p = 0.013$), while respondents that had worked for at least ten years, and those that work more than eight hours a day were more likely to have lung function abnormalities with corresponding p-values of 0.011 and 0.01.

Distribution of mean spirometric parameters by socio-demographic characteristics

Table 3 shows that respondents that were married had significantly lower mean values for FEV_1, and FEV_1: FVC compared to those that were unmarried with p-values of 0.004 and 0.006 respectively. Respondents involved in parboiling had significantly higher ($p<0.05$) mean values of FVC, and FEV_1, while those involved

in paddy separation had significantly lower ($p<0.05$) mean values for FVC and FEV_1. Also, respondents who worked more than 8 hours a day had a significantly lower ($p<0.05$) mean value of FEV_1.

Distribution of mean spirometric parameters by respondents' age, education status, and duration of work

Table 4 shows that the mean values for FVC and FEV_1 were highest among respondents that had worked less than 10 years and were lowest among those that had worked at least 20 years, these were statistically significant with p-values of 0.038 and 0.001 respectively. Post-hoc analysis for FEV_1 showed that respondents that had worked less than 10 years had a significantly ($p = 0.006$) higher mean as compared to those that have worked 20 years or more. Also, the mean values for FEV_1 and FEV_1: FVC were highest in respondents less than 20 years of age while those between the 20 to 29 age range had the highest mean value for FVC. Post-hoc analysis for FVC and FEV_1 showed that respondents aged 30 years and below had a significantly higher mean compared to those that were at least 50 years, while for FEV_1: FVC, post-hoc analysis showed that respondents less than 20 years of age had significantly higher mean values as compared to those that were at least 30 years of age.

Predictors of lung function abnormalities

Table 5 shows that respondents that were 30 years and above had about 3.3 times more odds of having lung function abnormality on spirometry compared to those that were younger, while respondents that worked longer than 8 hours per day were 2.4 times more likely to have lung function abnormality as compared to those that worked for lesser hours. Also, the odds of having abnormalities on spirometry were ten times higher among respondents with at least one symptom of respiratory morbidity as compared to those without symptoms.

Table 1: Comparison of actual and predicted mean values of lung function parameters of respondents

Variable	Actual mean (SD) (n = 394)	Predicted mean (SD) (n = 394)	Test statistic, (p-value)
FVC	3.63 (0.39)	4.29 (0.39)	t = -33.635, (p<0.001) *
FEV_1	3.01 (0.36)	3.67 (0.27)	t = -36.080, (p<0.001) *
FEV_1: FVC	0.83 (0.06)	0.86 (0.02)	t = -9.705, (p<0.001) *
t –one sample t- test; *p < 0.05			

Table 2: Association between respondent's socio-demographic characteristics and lung function abnormalities

Sociodemographic variables	Lung function abnormality		[a] Odds ratio, (p-value)
	Yes n = 119 n (%)	No n = 275 n (%)	
Age (years)			
< 30	72 (25.3)	213 (74.7)	2.24, **(p = 0.001)**
≥30	47 (43.1)	62 (56.9)	
Marital status			
Unmarried*	67 (26.7)	184 (73.3)	1.57, **(p = 0.044)**
Married	52 (36.4)	91 (63.6)	
Educational status			
Informal	75 (31.2)	165 (68.8)	0.88, (p = 0.572)
Formal	44 (28.6)	110 (71.4)	
Smoking			
No	92 (27.7)	240 (72.3)	2.01, **(p = 0.013)**
Yes	27 (43.5)	35 (56.5)	
Type of work			
Pre-cleaning			
No	73 (30.4)	167 (69.6)	0.97, (p = 0.908)
Yes	46 (29.9)	108 (70.1)	
Parboiling			
No	74 (35.2)	136 (64.8)	0.60, **(p = 0.020)**
Yes	45 (24.5)	139 (75.5)	

Drying			
No	64 (32.8)	131 (67.2)	0.78, (p = 0.263)
Yes	55 (27.6)	144 (72.4)	
De-husking			
No	74 (28.2)	188 (71.8)	1.31, (p = 0.233)
Yes	45 (34.1)	87 (65.9)	
Paddy separation			
No	49 (26.2)	138 (73.8)	1.44, (p = 0.10)
Yes	70 (33.8)	137 (66.2)	
Number of working days per week			
≤ 5	96 (29.7)	227 (70.3)	1.13, (p = 0.657)
>5	23 (32.4)	48 (67.6)	
Number of working hours per day			
≤ 8	72 (26.3)	202 (73.7)	1.81, **(p = 0.010)**
>8	47 (39.2)	73 (60.8)	
Length of working experience (years)			
<10	79 (26.8)	216 (73.2)	1.85, **(p = 0.011)**
≥10	40 (40.4)	59 (59.6)	
Symptoms of respiratory morbidity			
No	15 (9.3)	147 (90.7)	7.96, **(p <0.001)**
Yes	104 (44.8)	128 (55.2)	
[a] Crude Odds ratio			

Table 3: Distribution of mean spirometric parameters by socio-demographic characteristics

	FVC	FEV_1	FEV_1: FVC
Marital status			
Unmarried*	3.649	3.055	0.838
Married	3.584	2.942	0.821
t- test	1.588	2.900	2.764
p value	0.113	0.004	0.006
Smoking			
No	3.630	3.020	0.832
Yes	3.600	2.982	0.829
t- test	0.481	0.770	0.484
p value	0.632	0.442	0.628
Pre-cleaning			
No	3.627	3.005	0.829
Yes	3.624	3.028	0.836
t- test	0.066	-0.611	-1.185
p value	0.947	0.542	0.237
Parboiling			
No	3.567	2.955	0.829
Yes	3.692	3.082	0.836
t- test	-3.173	-3.520	-1.187
p value	0.002	<0.001	0.236
Drying			
No	3.593	2.980	0.829
Yes	3.657	3.048	0.835
t- test	-1.631	-1.898	-1.018
p value	0.104	0.058	0.309

De-husking			
No	3.630	3.029	0.835
Yes	3.616	2.986	0.825
t- test	0.354	1.039	1.611
p value	0.723	0.300	0.108
Paddy separation			
No	3.675	3.078	0.839
Yes	3.581	2.957	0.826
t- test	2.399	3.390	2.281
p value	0.017	0.001	0.023
Number of working days per week			
≤ 5	3.615	3.011	0.833
>5	3.671	3.030	0.825
t- test	-1.078	-0.393	1.179
p value	0.282	0.694	0.239
Number of working hours per day			
≤ 8	3.649	3.041	0.834
>8	3.572	2.954	0.827
t- test	1.785	2.207	1.000
p value	0.075	0.028	0.318

Table 4: Distribution of mean spirometric parameters by respondents' age, education status, and duration of work

Variables	FVC	FEV_1	FEV_1: FVC
Age group (years)			
< 20	3.649	3.099	0.851
20 – 29	3.670	3.059	0.834
30 – 39	3.554	2.918	0.821
40 – 49	3.491	2.831	0.812
≥ 50	3.015	2.395	0.795
f- test	4.799	8.188	3.401
p value	0.001	<0.001	0.009
Educational status			
Nil	3.591	3.001	0.838
Quranic	3.607	2.996	0.831
Primary	3.664	3.045	0.833
Secondary	3.630	3.025	0.833
Tertiary	3.908	3.250	0.830
f- test	0.892	0.741	0.099
p value	0.468	0.565	0.983
Length of working experience (years)			
<10	3.653	3.050	0.835
10-19	3.563	2.940	0.826
≥ 20	3.492	2.830	0.8010
f-test	3.307	6.756	2.970
p value	0.038	0.001	0.052

Table 5: Binary logistic regression analysis of factors significant in Chi-square test

Variables	aOR	95% Confidence Interval		p value
		Lower	Upper	
Age (<30yrs* vs ≥ 30yrs)	3.268	1.337	7.987	0.009
Marital status (unmarried* vs married)	0.685	0.322	1.457	0.325
Smoking (non-smokers* vs smokers)	1.441	0.772	2.689	0.252
Parboiling (No* vs Yes)	0.733	0.441	1.219	0.231
Number of working hours per day (≤ 8 hours* vs >8 hours)	2.433	1.420	4.167	0.001
Length of working experience (< 10 years* vs ≥ 10yrs)	1.106	0.484	2.527	0.811
Symptom of respiratory morbidity (No* vs Yes)	10.054	5.304	19.058	<0.001

*reference value; aOR- adjusted odds ratio

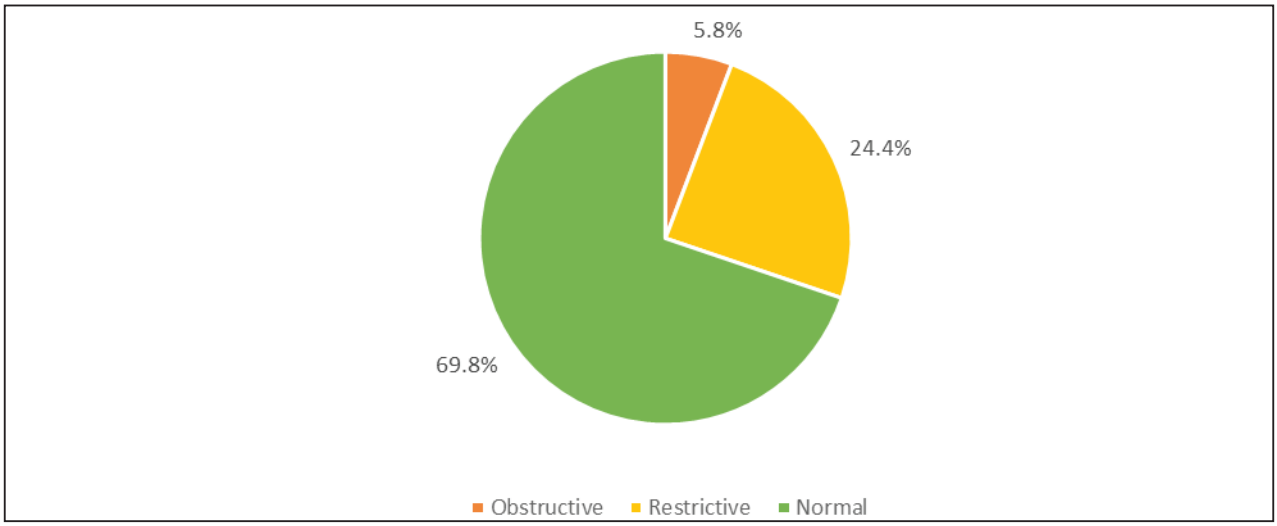

Figure 1: Categorization of lung function abnormalities among respondents

Discussion

Previous studies amongst rice mill workers have demonstrated the detrimental effects of chronic dust exposure on lung function.[11,19,20] This study lays credence to that as about a third of the workers were already having lung function abnormalities on spirometry. The prevalence of lung function abnormalities reported in this study may be relatively lower when compared to the prevalences reported in earlier studies among rice mill workers,[4,27] nonetheless, this is disturbing because the majority of the respondents in the current study are relatively younger, and had fewer years of work experience as compared to those in previous studies. Hence, there is a need for urgent measures to reverse this trend before serious disease develops.

The mean values of FVC and FEV_1 obtained in our study were higher compared to previous studies in Nigeria,[20] Malaysia,[18] and India.[19] This difference is unexpected because a large proportion of respondents in this study still have their normal respiratory functions preserved since they have only worked a few years in the rice mill. However, these means were significantly reduced when compared with predicted values for age and height. Similar reductions have been observed among rice mill workers in Nigeria[20] and India,[19] and this further demonstrates the harmful effect rice dust has on respiratory health.

An increase in the length of years of work often comes with increased damage to the respiratory tissues because of repeated inflammatory reactions. This has been demonstrated in previous studies among workers exposed to grain dust,[4,28] and the current study also shows this, as the mean FVC and FEV_1 reduced with the length of years of work in the rice mills. Although this reduction peaked at 20 years, workers who had worked for less than 10 years had significantly higher mean values and this further demonstrates the usual time lag between exposure and onset of occupational respiratory diseases.

This study showed the crucial role age and number of hours employees worked per day play in the development of respiratory abnormality. Age is one

of the social determinants of health and has always been a major risk factor in several disease conditions. Therefore it is not surprising that rice mill workers aged 30 years or more were three times more likely to have lung function abnormalities. A similar finding was reported in a previous study among workers exposed to reed dust.[29] Also, working beyond eight hours a day increases the risk of having lung function abnormality more than two folds. This is similar to finding in another study in Ethiopia[5] and further lays credence to the International Labour Organization's recommendation of not allowing employees to work beyond eight hours a day. Therefore, ensuring that employees do not work beyond 8 hours a day, and implementing environmental control measures to reduce dust exposure will go a long way in improving their respiratory health.

The current study also showed that having at least one symptom of respiratory abnormality is highly suggestive of having lung function abnormality. This is significant and means that the presence of symptoms of respiratory morbidity among workers exposed to dust can be used as a screening tool among workers in resource-poor settings where expertise and access to lung function examinations may be limited. A similar finding was reported in a study among marble stone workers in Myanmar.[30]

Conclusion

This study showed that the prevalence of lung function abnormality among rice mill workers in Sokoto state is relatively high and age, number of hours worked per day and having at least a symptom of respiratory morbidity were the factors associated with lung function abnormalities. Therefore, we recommend that Government and rice mill owners should ensure adequate environmental control measures in all rice mills and also promote optimal use of personal protective equipment by all the workers.

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