RESPIRATORY HEALTH PROBLEMS, PULMONARY FUNCTIONS AND CORRELATES AMONG RICE MILL WORKERS IN EBONYI STATE, NIGERIA.

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ABSTRACT:

Background

The aim of this study was to assess the prevalence of respiratory health problems, lung function and correlates among rice mill workers.

Materials and Methods

A cross sectional study was carried out among 150 workers consecutively recruited at the Abakaliki Rice Mill industry, Nigeria. Lung functions were measured using spirometer. Data were analysed using Epi-Info version 3.5.3.

Results

The commonest respiratory symptoms among rice mill workers were rhinitis 65 (43.3%) and blocked nostrils 62 (41.3%). Less than half of the participants 61 (40.7%) had abnormal lung function pattern, 45 (30.0%) had a restrictive lung function pattern, 13 (8.7%) had obstructive lung pattern and only 3 (2.0%) had a combined lung pattern.

Conclusions

There is a high prevalence of respiratory symptoms and abnormal lung function patterns, mostly restrictive. There is need for education on dust control and enforcement on use of personal protective equipment among rice mill workers.

Key words: Rice mill, lung functions, respiratory symptoms, Abakaliki, South East Nigeria

INTRODUCTION

It is well established that dust inhalation is a major occupational health hazard affecting the respiratory system.[1, 2] Dust exposure causes inflammatory reactions of the pulmonary tissues, eosinophilia, and asthma-related diseases.[3 - 6] Rice milling process involves pre-cleaning, de-stoning, parboiling, de-husking, paddy separation, polishing, weighing and bagging.[7, 8] These processes generate various materials including the husks, the bran, and the milled rice kernel.[7,8] Rice mill workers are, therefore, potentially exposed to dust and rice husk.

There have been many reports on health effects of rice husk exposure. Respiratory symptoms, including chronic cough, sputum production, nasal, and skin irritation, and chest tightness are common symptoms among rice mill workers. Others include asthma, allergic alveolitis, chronic bronchitis, as well as acute and chronic lung function impairment.[9-13] A study conducted to evaluate the health hazards of workers, in five rice mills of Davangere city, Karnataka, India found that 62% of the respondents complained of some respiratory morbidity while 72% of the participants had abnormal spirometry reading, (49% obstructive disorders and 47% were restrictive disorder).[14] A study from three districts of Karnataka, India found that rice mill workers exposed to dust presented significantly with lower levels

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of Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV1) and Peak Expiratory Flow Rate (PEFR) than the controls.[11] Similar study found FVC to be significantly reduced with duration of work in the rice mills.[15]

Although studies on respiratory problems of rice millers have been carried out in some other major rice producing parts of the world, especially Asia, studies conducted among rice mill workers in Nigeria have not objectively assessed the impact of occupational exposure to dust among the subjects using standard procedures like spirometry.[9 – 13, 16 - 18] Available studies in Nigeria though have assessed lung functions among different occupational groups exposed to various dusts.[4, 5, 19] There is, still, paucity of evidence indicating the respiratory morbidities among rice mill workers in Nigeria using lung function tests such as spirometry to assess pulmonary function tests. Furthermore, burden estimation is an important public health tool to inform risk reduction strategies and the prevention of disease caused by workplace exposures.[20]
The aim of this study was to assess the respiratory health morbidities in this group of workers, as well as pulmonary functions and correlates, using a population of workers at the Abakaliki Rice Milling Industry, Ebonyi State, Southeast Nigeria.
Materials and methods

Study design
This was a cross sectional study conducted from October 2019 to April 2020.

Study area
The study was carried out at the Abakaliki Rice Milling Industry, Abakaliki, Ebonyi State in the Southeast of Nigeria. Ebonyi State has an estimated population of 4,339,136 based on the 2005 census and the inhabitants are spread across 5,935 square kilometres.[21] Ebonyi is primarily an agricultural region. Rice and yams are predominantly cultivated in the state. There is a central mill known as Abakaliki Rice Mill Industry which covers large hectares of land, located in Abakaliki. People from far and near come to mill, buy or sell rice in Abakaliki rice mill industry.[22]

Study population
The study was carried out among Rice mill workers registered with their trade unions who had been in continuous employment for at least one year preceding the study. The study was conducted among the different categories of workers at the rice mill including the machine operators, the baggers, the loaders, the winnowers, the sellers and the administrative workers. All the workers at rice mills aged >18 years and willing to participate were included in the study. Exclusion criteria were known case of bronchial asthma, tuberculosis, those with history of vertebral column abnormalities, recent surgery of the thorax, abdomen who may have difficulty in performing the lung function test accurately and those who were pregnant.

Sampling
Sample size of 150 was determined using the formula for proportions when the population is infinite ($N = Z^2(pq)/d^2$) using a referenced prevalence of 0.7 from a previous study.[14] Participants were consecutively recruited until sample size was achieved. The milling industry is divided into 5 sections with 30 (units) shops per each section and 5 workers per shop. Sample size was first by selection of 15 shops per section by simple random sampling using the balloting method. Next is the selection of 2 workers in each selected shop who have met the inclusion criteria giving a total of 150 participants.

Data collection
Questionnaire administration
A pre-tested semi-structured, interviewer-administered questionnaire adapted from British Medical Research Council's Committee on Environmental and Occupational Health was used.[23] It was pretested in another rice mill in Ugbawka, Nkanu East, Enugu State. About 20 questionnaires were pre tested and the shortcomings in relevance, scope and use of tools were corrected before final administration. Data collections and measurements were done using research

assistants who were three residents. They were trained for two days, two hours per day on data collection, lung function measurements using spirometer and weight and height measurements. The questionnaire was translated to Igbo (local dialect) where the respondent is not fluent in English. The questionnaire consisted of five sections and thirty six items which elicited information on the socio-demographic characteristics such as age, sex and marital status; occupational history such as duration of employment, working hours; history of respiratory symptoms including a set of questions on symptoms of cough, phlegm, nasal congestion, breathlessness and wheezing), past medical and smoking habits, and dust control measures.

Spirometry

Spirometry was performed using MiniSpir PC-Based Spirometer manufactured by Medical International Research Roma, Italy to assess the lung parameters (FVC, FEV_1, FEV1/FVC%, and PEFR) of participants, using the ERS/ATS guidelines 2005 protocol for spirometry performance and interpretation.[24]

The test was carried out with the respondents sitting up and the nose clip applied to prevent air leak through the nose. A minimum of three and maximum of eight readings was performed by each participant while the measured pulmonary function values were compared with the Nigerian reference values derived by Patrick and Femi-Pearse and the percentage of predicted values derived.[25]

Lung function parameters were Forced vital capacity (FVC) which is the maximum volume of air that can be breathed out forcefully and rapidly following a maximum inspiration, Forced expiratory volume in 1 second (FEV1) which is the volume exhaled during the first second of the FVC manoeuvre and FEV1/FVC which is the percentage of the FVC expired in the first second of maximal forced expiration following full inspiration.[26]

The outcomes of spirometry test were classified as follows;

Obstructive - FEVI/FVC < the lower limit of normal (LLN) with FVC ≥ LLN

Suggestive of restrictive - FVC < LLN with FEV1/FVC ≥ LLN

Mixed (obstructive and suggestive of restrictive) - FEV1/FVC < LLN with FVC < LLN

Normal - FEV1/FVC ≥ LLN with FVC ≥ LLN.

Normative values used for characterization of spirometry pattern were those of the Global Lung

Function Initiative (GLI) reference equation for "others".[27, 28] Appropriate precaution was taken to prevent cross infection during spirometry by using a disposable mouth piece for each participant.

Anthropometry

Height and weight were measured using the standard protocols recommended by the International Society for the Advancement of Kinanthropometry (ISAK).[29] Weight of the respondents in kilogram (kg) was measured using a Leicester weighing scale set at zero mark while height of the respondents in centimeters (cm) was measured using a portable Leicester height stadiometer both manufactured by SECA. Height was measured without shoes to the nearest one centimeter and the body weight to the nearest one kilogram with respondent in the centre of the scale, with hands by his/her side, with light clothing and without shoes.[29]

Body mass index (BMI) was calculated through this formula: weight/squared height (kg/m2).[30]

Particulate Measurement

Two points were selected from each of the five sections in the rice mill industry for dust sampling of particulate matter using a simple random sampling (balloting). In each of the selected points, particulate matter concentrations of $PM_{2.5}$ and PM_{10} were determined using a low cost PM sensor, a digital handheld IGERESS intelligent air quality monitor between the hours of 10am and 4.00pm. The World Health Organization

(WHO) recommended acceptable levels of 25 μg/m^3 and 50 μg/m^3 24-hour mean in workplaces for $PM_{2.5}$ and PM_{10} respectively was used as the reference occupational exposure limit.[31] Before performing the PM measurement, the sensor was calibrated according to the manufacturer's instruction.

Statistical analyses

Data entry and analysis were done using Epi-Info version 3.5.3 by Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia (US). Categorical data were summarized as proportions and percentages while continuous variables were summarized using means (± standard deviation). Bivariate analysis was carried out using Chi-square test to establish associations with P value set at 0.05.

Ethical considerations

Ethical clearance was obtained from the the Health Research and Ethics Committee of University of Nigeria Teaching Hospital (UNTH), Enugu. Permission was also obtained from the management of the Abakaliki Rice Mill Industry and the trade union executives of the rice millers while informed consent was obtained from participants. The participants were informed that they have full rights to refuse and discontinue taking part at any point in the study at any time they so wish. The study participants with lung function impairments were advised and linked to a health facility for further evaluation.

Results

Socio-demographic characteristics

Table 1 Showed the socio-demographic characteristics of the participants. The mean age of the rice mill workers was 44.08 ± 12.02 years while participants between 46 - 55 years had the highest proportion 56 (37.3%). Majority of the participants were female 111 (74.0%) while 39 (26.0%) were male. Majority of the participants were married 89 (59.3%) with most of them being of Igbo ethnic group. A higher proportion of the participants 66 (44.0%) had no formal education while only 16 (10.7%) had tertiary education. Majority of the participants were of normal BMI 81 (54%), 28 (18.7%) were underweight while 11 (7.3%) were obese.

Work characteristics

Table 2 showed the proportion of the rice mill workers and their job description. Their jobs ranged from winnowing 59 (39.3%) to polishing 5 (3.3%). Majority 106 (70.7%) had worked between 1-10 years while up to a third 44 (29.3%) had worked for more than 10 years. The mean years of work experience was 5 years. Majority of the participants worked 6 days per week 127 (84.7%) and 6-10 hours per day 128 (85.3%) respectively.

Prevalence of respiratory symptoms

Table 3 showed the prevalence of respiratory symptoms among rice mill workers. A higher proportion 48 (32.0%) reported they had cough at the time of the study while up to 10 (6.7%) had coughed for more than three months. The occurrence of phlegm first thing in the morning was reported by 32 (21.3%) of the rice mill while 11 (7.3%) reported producing phlegm for up to three months a year. Sixty-five (43.3%) of the participants had nasal discharge while 62 (41.3%) reported blocked nostrils. The occurrence of self-reported shortness of breath walking on ground / slight hill among the participants was in 37 (24.7%) while 21 (14%) reported shortness of breath at rest. Wheezing was reported by 17 (11.3%) of the participants.

Table 3 also showed the medical and social history of the participants. Twelve (16.9%) of the participants were ex-smokers and had taken more than one cigarette per day while 34 (23%) reported sniffing snuff.

Knowledge of health effects of rice dusk and dusk inhalation control measures

Table 4 showed that almost half of the participants 74 (49.3%) knew that inhalation of rice dusk is harmful but despite the knowledge, a higher proportion of them 68 (91.9%) did nothing to prevent rice dusk inhalation while only 1 (1.4%) participant wore dust mask while working. Unavailability of the mask was the major reasons for nonuse of dust mask by majority 121 (80.7%) of the participants.

Lung function Test

Table 5 showed the different lung function patterns of the rice mill workers from the spirograph. FVC was abnormal in 66 (44.0%) of the participants, FEV1was abnormal in 70 (46.7%) while 6 (4.0%) had abnormal FEV1/FVC. Overall, over half of the participants 89 (59.3%) had normal lung function pattern, 45 (30.0%) had a restrictive lung function pattern, 13 (8.7%) had obstructive lung pattern and only 3 (2.0%) had a combined lung pattern.

Factors associated with abnormal lung function patterns

Table 6 showed that no socio-occupational factors were significantly associated with having abnormal lung functions among the respondents. Tables 7 and 8 also showed no socio-occupational factors were associated with restrictive or obstructive lung pattern.

Particulate Matter levels

The mean PM levels measured at ten different work sections in the rice mill market. The mean PM2.5 concentration was 51 ± 6.674 µg/m3. The mean PM10 concentration was 57.60 ± 7.260µg/m3.

Table I: Socio – demographic characteristics and body mass index of respondents

Variables	Frequency	Percent
Age		
[illegible]	13	8.7
26 – 35	29	19.3
36 – 45	31	20.7
46 – 55	56	37.3
55 – 65	20	13.3
66 – 75	1	0.7
Mean	44.08	
Standard deviation	12.02	
Sex		
Male	39	26.0
Female	111	74.0
Ethnicity		
Igbo	146	97.3
Yoruba	2	1.3
Others (Igala)	2	1.3
Marital status		
Single	16	10.7
Married	89	59.3
Divorced / Separated	0	0.0
Widowed	45	30.0
Educational level		
None	66	44.0
Primary	45	30.0
Secondary	23	15.3
Tertiary	16	10.7
***Body mass index**		
Weight		
Mean	56.95	
Standard deviation	14.52	
Height		
Mean	1.59	
Standard deviation	0.10	
Under weight (BMI)	28	18.7
Normal weight (BMI)	81	54.0
Over weight (BMI)	30	20.0
Obesity (BMI)	11	7.3

Table II: Occupational history of respondents

Variables	Frequency	Percent
Work description		
Machine operator	12	8.0
Dehusking	32	21.3
Polishing	5	3.3
Destoning	17	11.3
Winnower	59	39.3
Administrative worker	25	16.7
Years worked in rice mill		
1 – 10 years	106	70.7
11 – 20 years	29	19.3
21 – 30 years	11	7.3
31 – 40 years	4	2.7
Median	5.00	
No of days worked per week		
1	1	0.7
2	0	0.0
3	6	4.0
4	3	2.0
5	12	8.0
6	127	84.7
7	1	0.7
Mean	5.73	
Standard deviation	0.79	
Working hours per day		
1 – 5	1	0.7
6 – 10	128	85.3
11 – 15	21	14.0
16 – 20	0	0.0
21 – 25	0	0.0
Mean	10.00	
Standard deviation	1.34	

Table III: Clinical, past medical and smoking history of respondents

Variables	Frequency	Percentage
Respiratory symptoms		
Cough	48	32.0
Morning cough	25	16.7
Day or night cough	42	28.0
Cough for 3 months / year	10	6.7
Morning Phlegm	32	21.3
Day or night phlegm	22	14.7
Phlegm for 3 months / year	11	7.3
Nasal discharge	65	43.3
Blocked nostril	62	41.3
Dyspnea on exertion	37	24.7
Dyspnea at rest	21	14.0
Wheezing	17	11.3
Past Medical and smoking History		
Chest injury or operation	2	1.3
Heart problem	1	0.7
Smoking	12	16.9
Snuff	34	23.0
More than one cigarette per day	12	16.9

Table IV: Knowledge of health effects of rice dusk, dusk inhalation control measures and reasons for not using dust mask

Variables	**Frequency**	**Percent**
Respondents who agreed that rice husk inhalation is harmful	74	49.3
Preventive measures taken by respondents (n=74)		
Nothing	68	91.9
Improved ventilation	2	2.7
Washing soon after work	1	1.4
Wearing Overall	1	1.4
Dust mask	1	1.4
Respirators	0	0.0
Wetting of floor	0	0.0
Others (e.g. change of clothing)	1	1.4
Have seen a dust mask (yes) n=150	56	37.3
Reasons for not using dust mask		
Not of much use	20	13.3
Disturb my breathing	3	2.0
Disturb my talking	5	3.3
Expensive	1	0.7
Not available	121	80.7
Willingness to wear a mask (yes)	144	96.0

Table V: Pattern of Lung function test among respondents using Spirometry readings

Variables	Frequency	Percent
FVC		
Normal	84	56.0
Abnormal	66	44.0
FEV1		
Normal	80	53.3
Abnormal	70	46.7
FEV1 / FVC		
Normal	144	96.0
Abnormal	6	4.0
Lung function test		
Normal	89	59.3
Abnormal	61	40.7
Lung disease		
Obstructive	13	8.7
Restrictive	45	30.0
Combine	3	2.0

Table VI: Socio – demographic / occupational factors associated with lung function tests.

	Lung function test		Statistical test	
Variables	**Normal**	**Abnormal**	**Chi – square**	**P - value**
Age				
= 45 Years	38 (52.1)	35 (47.9)	0.653	0.513
>45 Years	35 (45.5)	42 (54.5)		
Marital status				
Single	9 (56.2)	7 (43.8)	2.046	0.378
Married	46 (51.7)	43 (48.3)		
widowed	18 (40.0)	27 (60.0)		
Gender				
Male	23 (59.0)	16 (41.0)	2.241	0.142
Female	50 (45.0)	61 (55.0)		
Educational level				
None	33 (50.0)	33 (50.0)	6.034	0.110
Primary	16 (35.6)	29 (64.4)		
Secondary	15 (65.2)	8 (34.8)		
Tertiary	9 (56.2)	7 (43.8)		
Work description				
Direct dust contact	52 (46.0)	61 (54.0)	1.287	0.344
Limited or indirect dust contact	21 (56.8)	16 (43.2)		
Years worked				
= 10 years	47 (44.3)	59 (55.7)	2.708	0.110
>10 years	26 (59.1)	18 (40.9)		
Days per week				
= 5 days	10 (45.5)	12 (54.5)	0.106	0.820
>5 days	63 (49.2)	65 (50.8)		
Hours per day				
= 8 hours	20 (60.6)	13 (39.4)	2.414	0.167
>8 hours	53 (45.3)	64 (54.7)		

Table VII: Socio – demographic / occupational factors and presence of restrictive lung disease.

	Lung function test		Statistical test	
Variables	**Normal**	**Abnormal**	**Chi – square**	**P - value**
Age				
= 45 Years	46 (63.0)	27 (37.0)	3.305	0.077
>45 Years	59 (76.6)	18 (23.4)		
Marital status				
Single	12 (75.0)	4 (25.0)	0.455	0.807
Married	63 (70.8)	26 (29.2)		
widowed	30 (66.7)	15 (33.3)		
Gender				
Male	28 (71.8)	11 (28.2)	0.081	0.841
Female	77 (69.4)	34 (30.0)		
Educational level				
None	40 (72.7)	18 (27.3)		0.622
Primary	28 (62.2)	17 (37.8)		
Secondary	17 (73.9)	6 (26.1)		
Tertiary	12 (75.0)	4 (25.0)		
Work description				
Direct dust contact	78 (69.0)	35 (31.0)	0.207	0.686
Limited or indirect dust contact	27 (73.0)	10 (27.0)		
Years worked				
= 10 years	72 (67.9)	34 (32.1)	0.741	0.439
>10 years	33 (75.0)	11 (25.0)		
Days per week				
= 5 days	14 (63.6)	8 (36.4)	0.497	0.615
>5 days	91 (71.1)	37 (28.9)		
Hours per day				
= 8 hours	27 (81.8)	6 (18.2)	2.814	0.131
>8 hours	78 (66.7)	39 (33.3)		

Table VIII: Socio – demographic / occupational factors and presence of obstructive lung diseases.

	Lung function test		Statistical test	
Variables	**Normal**	**Abnormal**	**Chi – square**	**P - value**
Age				
= 45 Years	67 (91.8)	6 (8.2)	0.036	1.000
>45 Years	70 (90.9)	7 (9.1)		
Marital status				
Single	13 (81.2)	3 (18.8)		0.202
Married	81 (91.0)	8 (9.0)		
widowed	43 (95.6)	2 (4.4)		
Gender				
Male	34 (87.2)	5 (12.8)	1.149	0.324
Female	103 (92.8)	8 (7.2)		
Educational level				
None	62 (93.9)	4 (6.1)		0.279
Primary	42 (93.3)	3 (6.7)		
Secondary	20 (87.0)	3 (13.0)		
Tertiary	13 (81.2)	3 (18.8)		
Work description				
Direct dust contact	105 (92.9)	8 (7.1)	1.458	0.309
Limited or indirect dust contact	32 (86.5)	5 (13.5)		
Years worked				
= 10 years	94 (88.7)	12 (11.3)		0.109**
>10 years	43 (97.7)	1 (2.3)		
Days per week				
= 5 days	20 (90.9)	2 (9.1)		1.000**
>5 days	117 (91.4)	11 (8.6)		
Hours per day				
= 8 hours	31 (93.9)	2 (6.1)		0.734**
>8 hours	106 (92.3)	11 (9.4)		

**Fischer's Exact test

DISCUSSION

The socio-demographic characteristics of the participants showed that they were mostly women around middle age and majority of them had no formal education. A previous study had established that women form a greater percentage of Abakaliki rice mill workforce and are involved in most aspects of production including dehusking, winnowing, drying of paddy, piling of the paddy, cleaning the threshing floor and packing the rice.[18] This was in contrast to the socio-demographics of rice mill workers in some Indian studies where the workers were mostly male and younger with only a minority being illiterate.[32, 33] This was probably because our respondents were largely those involved in winnowing and dehusking which are considered menial jobs for women in this setting, in addition to the fact that rice farming and marketing are mostly carried out by women.[34]

Similar to other studies, this current study found various respiratory symptoms among rice mill workers, including cough, morning phlegm, nasal irritation/blockade, shortness of breath and wheezing. Comparable levels of occurrence of these symptoms were reported by different studies although with some slight variations.[9 - 12] Rhinitis was the most commonly reported symptom among our

respondents (43.3%) whereas, other authors reported as the commonest symptoms, dyspnea (44.2 %), cough (32%, 18%), and phlegm production (27%).[9 - 12] These respiratory symptoms are likely as a result of allergic response to rice husk or certain microbial or parasitic contaminants in the rice husk dust.[11]

This study showed that only about half of the participants knew that inhalation of rice dusk is harmful, but despite the knowledge, most of them (68, 91.9%) did nothing to prevent rice husk inhalation while only 1(1.4%) participant wore dust mask while working. A study in Abakaliki, South East, Nigeria also found low level of awareness of occupational health hazards and non-use of protective mask among the women at the same rice mills.[18] Major reason for nonuse of face mask by the respondents was unavailability. Corroborating the observation, similar study in same environment found that personal protective equipment were not available for use by the rice mill workers.[17] Besides unavailability of protective mask, low level of awareness, low perception of risk and illiteracy may all contribute to their non-use as most of them have little or no formal education. The implication of their non-use of mask is that the workers face a higher risk of respiratory morbidity due to dust exposure than if they wear masks. A study in West Bengal, India reported a risk of respiratory morbidity of 12 times more among subjects who were not using any protective measures when they studied 258 rice mill workers.[32] Providing common face masks by the employers might be a high yield intervention, seeing a high level of willingness to wear a mask (96%) if provided among the participants in this study.

Spirometry carried out in this study showed that slightly almost half (40.7%) of the participants had abnormal lung function patterns which were mostly restrictive in nature compared to the obstructive type (30.0% versus 8.7% respectively). Similar patterns of lung functions were obtained in Karnataka, India where majority of the workers (31.8%) had restrictive pattern of lung diseases and 9.2% had obstructive lung diseases.[16] Also in West Bengal, lung function abnormality of 40.3% with more of restrictive than obstructive pattern (24.60% versus 16.13%) were noted.[32] In another study, however, it was found that as much as 72% of the rice millers had abnormal spirometry reading with almost equal proportions of obstructive and restrictive disorders (49% obstructive disorders and 47% were restrictive disorder).[14] Ultimately, these findings underscore the high prevalence of restrictive lung disorders among rice mill workers. Furthermore, abnormal FVC and FEV1 found in 44.0% and 46.7% respectively, of the participants in this present study, agrees with lower lung volumes found in studies which compared rice mill workers with controls.[10, 11] This further strengthens the well-established relationship between rice milling and pulmonary function abnormalities.

This study found no socio – demographic and occupational that were significantly associated with abnormal lung functions among the respondents. This contrasts with findings from West Bengal India where age, average duration of working hours per day, duration of working experience (years) in rice mill, use of any protective measures, and smoking status were significantly associated with respiratory morbidity.[32] The contrast might be explained by a more modest sample size adopted by this study. A study in Sri Lanka found that lung volumes were significantly further reduced in females than in male millers following exposure to dust over a few hours,[10] whereas no sex predilection was observed in this present study.

Dust sampling of 10 sections of the rice mill showed a mean PM10 concentration of 57.60+ 7.260µg/m3, which is above the WHO recommended acceptable level PM10 of 50 µg/m^3 24-hour mean as the reference occupational exposure limit. This clearly indicates that workers at this rice mill are exposed to a high level of occupational dust which are likely responsible for the respiratory symptoms and abnormal lung

function patterns observed in the workers. This finding corroborates a study which recorded high levels of dust particles (smaller than 10μ) than the standard permissible value at local rice mills in Thailand, associated with restrictive lung disorder in all four workers examined by spirometry.[35] There is, therefore, need for better engineering control and housekeeping to be instituted to reduce dust exposure among workers.

This study has a demonstrated the occurrence of various respiratory symptoms among the Abakaliki Rice mill workers. There is a high prevalence of abnormal lung function patterns, especially restrictive lung disease and a high level of dust exposure. Workers and employers at the rice mill require education on the need for dust control and personal protection.

Limitations

This study was done in one urban area of Ebonyi State and therefore cannot be generalized. Instrument used for measuring the particulate matter has not been validated. A review done among several studies that adopted the low cost PM sensors found that they have some limitations [36], and so the dust sampling result needs to be interpreted with caution. Further studies comparing pulmonary functions among rice mill workers and control in this setting is suggested.

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Institution and Ethics approval and informed consent: Ethical clearance was obtained from the the Health Research and Ethics Committee of University of Nigeria Teaching Hospital (UNTH), Enugu. Permission was also obtained from the management of the Abakaliki Rice Mill Industry and the trade union executives of the rice millers while informed consent was obtained from participants.

Conflict of Interest: The authors declare that they have no competing interests.

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