Evaluation of Peak Expiratory Flow Rates (PEFR) of Workers in a Cement Factory in Port Harcourt South-South, Nigeria.

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ABSTRACT:

Background: Occupational lung diseases (OLD) remain one of the most common workplace health challenges since the industrial revolution. One of the risks for OLD is the exposure to cement dust which is associated with varying degrees of respiratory symptoms and reduction in lung function. This study aimed to measure the peak expiratory flow rates (PEFR) of workers in a cement manufacturing company in Port Harcourt and estimate the determinants of the measured rates.

Method: In this descriptive cross-sectional study, 105 workers of a cement company who presented for the annual fitness to work exercise were sampled and had their peak expiratory flow rates measured using a spirometer. Data were also collected using structured interviewer-administered questionnaires and a walk through survey carried out to examine workplace situation. The results were analyzed using descriptive and inferential statistics.

Results: The study showed that 13.3% of the workers had abnormal (i.e low) PEFR. The lowest mean PEFR of 327.5L/min was found among workers who had worked for 21 23 years and worked mainly at the production and bagging area. Most of the workers (81.9%) made effective use of some form of personal protective equipment (PPE).

Conclusion: Reduction in the PEFR implied that prolonged exposure to cement dust may result in decreased lung function and by extension pulmonary disease. The high percentage of normal PEFR found among the workers, irrespective of their duration of work, could be attributed to the effective use of the PPE.

Key words: Peak Expiratory Flow Rate

INTRODUCTION

The number of people who work in dusty environments on a daily basis remains alarming[1], in spite of the advances in technology and knowledge of occupational health associated with the twenty-first century.

These workers are exposed to different types of health hazards such as fume, gases and dust, which are implicated in the development of occupational lung diseases(OLD)[2].
The dust generated in these factories or work environments may either be organic (such as sugarcane, wood and cotton dust) or inorganic (such as asbestos dust, coal dust, iron dust and cement dust)[3].

The amount of dust generated in the production of cement is enormous irrespective of the types which are mainly natural and artificial (Portland) cement[3]. Consequently workers at every stage of the process (viz quarrying, grinding, blending, packing and distribution) are exposed to the hazard of inhalation of the precipitate dust, fumes and even gas that may be generated[3,4].

The health risks posed by the inhaled inorganic cement dust particles are evident particularly in the respiratory system with significant impairment of lung function[5]. The aerodynamic diameter of Portland cement particles which

range from 0.05 to 5.0 micrometers, make them respirable particles and a potential cause of OLD[4,5].

The inhalation of cement dust in high doses and or over prolonged periods in cement manufacturing workers can provoke clinical symptoms and inflammatory response that may result in functional and structural abnormalities in various systems[6,7].

The most frequently reported clinical features in cement workers are respiratory symptoms and disorders such as rhinitis, chronic cough and phlegm production, chest tightness, wheezing, obstructive and restrictive lung diseases[1,8] and impairment of lung function. Other non malignant manifestations include extra pulmonary features like skin irritation, conjunctivitis, abdominal pain, headache and fatigue[9,10]. While adenocarcinoma of the nasopharynx[1], carcinoma of lung, stomach and colon[11,12] are some of the malignant diseases associated with occupational cement dust exposure.

In addition to respiratory symptoms and signs, various methods have been employed to evaluate respiratory function. One of such methods is the measurement of the Peak Expiratory Flow Rate (PEFR), which is a measure of how fast a person can breathe out after taking a deep breath[13].

The normal value of PEFR for adults is between 300 600 L/min [13,14], with variations for age, body height and size, gender and race[15]. The normal values for adult males and females range from 400 600 L/min and 300 500 L/min respectively[16], while the normal values in children range from 200 400 L/min. In a study done to establish standard values for PEFR in Nigeria, anthropometric measurements, lung volumes, and PEFR were obtained from 142 men and 88 women, all of whom were healthy Nigerians. The study noted that the mean values of PEFR were 482.1 L/min (±83.3) for males (average age 34.9 years) and 385.6 L/min (±65.7) for females (average age 29.4 years), both means being significantly lower than corresponding means of predicted values calculated from formulae based on previously reported studies of Caucasians[17].

Existing lung diseases such as bronchial asthma and other obstructive and restrictive pulmonary conditions significantly reduce the PEFR values[8,18]. A fall in peak flow can also signal the onset of a lung disease flare, especially when it occurs with symptoms such as increased cough, shortness of breath and wheezing[19]. PEFR measurement is therefore a useful screening tool for lung diseases in occupational settings[19], especially as it is a parameter that can easily be measured[1].

In spite of the established occupational hazards and adverse respiratory health effect of cement dust in Nigeria, the surveillance and regulation of occupational lung disease in Nigeria is suboptimal due to a weak systems and regulatory framework[21,22,23]. This makes the screening and surveillance of at risk persons for occupational lung disease important. This enhances early detection and institution of treatment to prevent permanent damage.

The study was carried out based on the afore-mentioned, to measure the PEFR of workers of this cement factory and investigate any related health implication.

METHODOLOGY:

Study design and population: This descriptive cross sectional study was carried out in one of the three Portland cement factories in Port Harcourt, Nigeria. This factory was selected after the other two factories declined to participate in the study.

The inclusion criteria for the study subjects were; workers who had worked in the factory for at least two years, at least 18years of age, no history of cigarette smoking and chronic respiratory disease.

The study carried out in June, 2011 had 105 workers randomly sampled by balloting from the company's 305 work force who presented for the yearly 'fitness to work' exercise. Their selection was based on the inclusion criteria as those who

did not meet the criteria were excluded from the study. There were no drop outs from the selected subjects.

Sample collection and analysis: A structured self administered questionnaire was administered by two trained assistants. The questionnaires probed bio-data, medical history (especially the respiratory system), job history, and safety practices. Informed consent was obtained even as confidentiality was implemented as the subjects were not identified by name. The questionnaires had been pre-tested among workers of glass making factory in Port Harcourt similar in sociodemographic characteristics and necessary amendments made subsequently. Also, a measuring tape was used for taking the height and chest circumference of the subjects while weighing scales for taking the weight. These measured parameters were later used to calculate the Body Mass Index (BMI) Kg/m^2.

A full Range Respironics® peak flow meter was used for measuring the peak flow rates of subjects. There was a walk through survey of the worksite which assessed general work place condition and safety.

The data were analyzed using descriptive (i.e. frequency and percentages) and inferential statistics (standard deviation and correlation).

Ethical considerations: Ethical approval for the study was obtained from the Institutional review board / Ethics and Research Committee of the University of Port Harcourt Teaching Hospital. Permission was also obtained from the cement company authorities and workers representatives. The workers provided signed informed consent prior to the commencement of the study.

Limitations: The single point evaluation may create bias, and the results will be reflective of the practice of that institution. Their probable high use of PPE and safety implementation informed the basis for their decision to participate, compared with those who declined who were probably hiding something.

RESULTS:

All administered 105 questionnaires retrieved from the respondents were satisfactorily completed.The overall mean age of the study subjects i.e. Table 1, was 35.3+7.5 (36.0+7.3 for males and 34.5+7.6 for females). The age range of the male and female workers showed that respondents in the age range 30 39 participated most (46.7%) just as most of the respondents (57.2%) had attained secondary level of education.

Overall mean BMI was $27.15 \pm 3.87 kg/m^2$ while the means for the male and female respondents were $25.76 \pm 3.72 kg/m^2$ and $28.53 \pm 4.57 kg/m^2$

Table 1: Demographic data of the workers sampled

Variable		Frequency	Percentage %
Age	20 - 29	21	20.0
	30 - 39	49	46.7
	40 - 49	34	32.4
	50 - 59	1	0.9
Sex	Male	98	93.3
	Female	7	6.7
Marital Status	Single	34	32.4
	Married	68	64.8
	Divorced	2	1.9
	Widowed	1	0.9
Level of Education	No formal Education	0	0.0
	Primary	29	27.6
	Secondary	60	57.2
	Tertiary	16	15.2
Category of Workers	Production	63	60
	Administration	6	6
	Cleaners	6	6
	Drivers	10	9
	Maintenance	8	8
	Marine	3	3
	Catering	6	5
	Security	3	3

Table 2: Mean values of the variables according sex

Variables	Males	Female
Age	36.0 ± 7.3	34.5 ± 7.6
Height	1.69 ± .08	1.64 ± 0.1
Weight	73.45 ± 11.48	76.57 ±9.98
BMI	25.76 ± 3.72	28.53 ± 4.57
Chest Circumference	90.27 ± 7.40	90.43 ± 9.06
PEFR	472.14 ± 91.04	445.71 ± 62.68

Table 3: Occupational History of the workers sampled

Variable		Frequency	Percentage
Duration of Work (Yrs)	0 – 5	46	43.8
	6 – 10	27	25.6
	11-15	14	13.5
	16 - 20	14	13.3
	21 - 25	4	3.8
No of Days worked per No of Week	5 Days	22	20.9
	6 Days	65	61.9
	7 Days	18	17.2
Exposure to Cement Dust based on self reporting	Yes	85	80.6
	No	20	19.4

Table 4: Analysis of the medical history of the workers sampled.

Medical History	Frequency	*Percentage %
No Respiratory Symptom	82	78.1
Cough of >4Wks Duration	15	14.3
Sputum Production	13	12.4
Fast Breathing	10	9.5
Chest Pain	21	20.0
Respiratory Medical Check-up in the Last 6 Months	3	2.9
Previous Hospital Admission	31	29.5
History of Asthma/ COPD	0	0.0

*Percentage of the total respondents in each variable of the medical history

Table 5: Analysis of the 14 cement workers with abnormal PEFR

Sex	Age Range (Yrs)	Duration of Work (Yrs)	Category of Workers	Use of PPE	BMI kg/m^2	Chest Circumference	Best PEFR (L/min)
M	20 - 29	3	Production	Always	26.4	79	260
M	30 - 39	12	Production	Rarely	25.5	90	290
M	30 - 39	12	Production	Rarely	22	86	350
M	30 - 39	2	Production	Occasionally	25.7	90	350
M	30 - 39	18	Production	Occasionally	22.9	91	370
M	30 - 39	1¾	Maintenance	Always	23.4	88	380
M	30 - 39	12	Production	Occasionally	43.3	120	300
M	40 - 49	23	Production	Rarely	25	83	250
M	40 - 49	10	Driver	Occasionally	28.3	95	350
M	40 - 49	19	Production	Occasionally	22.7	84	380
M	40 - 49	18	Production/	Occasionally	25.7	89	310
M	40 - 49	18	Production	Occasionally	19.7	78	350
M	40 - 49	21	Maintenance	Rarely	34.6	101	250
M	50 - 59	19	Production	Always	28.1	99	340

DISCUSSION

The Nigerian work environment like any other contains hazards and dust is one of them. The cement industry generates a lot of dust at each stage of production, distribution and even sale. Monitoring of workers at all stages especially production will help identify at risk persons and necessary intervention instituted early. This company with its reasonably high safety standards still has apparently healthy workers with abnormal PEFR hence the need for continuous monitoring.

This study showed that most of the workers were below the age of 40 years (i.e in the 30 39 age groups). This pattern is similar to that reported by Noor et al[20]. This finding could be due to the fact that cement production is stressful and energy demanding. It therefore requires the strength of persons of the younger age group. There were more males (93.3%) than females due to the very strenuous nature of the job and cultural norms as per women carrying and lifting heavy load.

Most of the workers had worked for at least 5 years with most working for at least 6 days a week. This increases exposure which in turn increases the risk of OLD from dust[22]. The most frequent respiratory symptoms were chest pain and cough. These are symptoms associated with OLD [22,23] and because of their work environment likely caused by cement dust although further clinical investigation may be required to see (if any) association with cement dust. This was also seen by Oleru and Abou Taleb in which chest tightness, chronic cough and sputum production were reported to be the most common symptoms among cement mill workers[1,15]. It was also same in a Cross Shift Study in Ethiopia on Cement Dust Exposure and Acute Lung Function [47] and evident in that to assess the Ventilatory Function of Workers at Okpela Cement factory [14, 18].

Most of the 14 workers with reduced lung function worked in the production area (where the most dust is generated) and a poor history of the use of PPE. Also, most of them had BMI greater than 23kg/m^2 and chest circumference greater than 80cm. These are all predisposing factors for reduced PEFR and ultimately OLD as documented by Oleru[1] and Alakija[18].

Conclusions: The study showed that 14 (i.e

13.3%) of the workforce in the cement factory has reduced lung function as expressed by a reduction in PEFR and which may lead to occupational lung disease. The key determinants of reduced lung function in this study were long duration of exposure, increased body mass index, poor use of PPE and enlarged chest circumference. This document's the risk of OLD from reduced lung function in cement dust exposed workers. It also showed that knowledge and effective use of PPEs is contributory to low percentage of workers with decreased lung function. It is therefore recommended that periodic and scheduled screening of lung function using simple tools like respiratory symptoms evaluation and PEFR should be done in workers at risk for early detection and prevention of OLD. The education and use of PPE should be encouraged and promoted as it has been shown to significantly reduce the risk of lung function impairment.

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