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RESPIRATORY SYMPTOMS AND PULMONARY FUNCTIONS AMONG MASONS AND OFFICE WORKERS IN BENIN CITY, NIGERIA

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ABSTRACT

Development and urbanization has increased construction of houses and roads in Nigeria and this has directly increased the number of workers exposed to cement dust. Our objective is to determine the prevalence of respiratory symptoms and ventilatory functions among masons and office workers in Benin City, Nigeria. This cross-sectional comparative study was carried out among 98 masons and 87 office workers in Benin City, Nigeria. Information on socio-demographic characteristics and respiratory symptoms were collected using sections of the validated BOLD questionnaire. Spirometry was carried out using a KoKo Legend spirometer. The masons (mean age 57.3 ± 11.3 years) were significantly older than the office workers (mean age 41.9 ± 11.6 years) [$p < 0.001$]. The masons had more symptoms of cough 27 (27.6%), phlegm 26 (26.5%), wheeze 26 (26.5%) and chest tightness 21 (21.4%) than the office workers with cough 5 (5.7%), phlegm 5 (5.7%), wheeze 4 (4.6%) and chest tightness 3 (3.4%) [$p < 0.001$]. The mean FEV_1, FEV_1/FVC ratio and PEFR of the masons were lower than that of office workers; 2.544L vs 2.749L ($p = 0.104$), 0.773 vs 0.851 ($p < 0.001$) and 6.105L vs 7.142L ($p = 0.004$) respectively. A higher proportion 17 (20.2%) of masons had obstructive respiratory abnormality ($p = 0.029$) while the office workers 23 (34.8%) had more restrictive respiratory abnormality ($p = 0.001$). Masons have a higher prevalence of respiratory symptoms and reduced lung functions especially obstructive respiratory abnormalities when compared with office workers. This finding should be of great concern to local health authorities in Nigeria.

INTRODUCTION

In Nigeria, the advent of development and urbanization has increased construction of houses and roads. This has directly increased the number of workers exposed to cement dust. Working in a dusty environment exposes workers to high concentration of dust such as cement dust.[1] Cement is an adhesive mineral dust containing mixture of calcium oxide, silicon oxide, aluminium trioxide, ferric oxide, magnesium oxide, clay, shale, sand, and other impurities.[2] Inhalation of cement dust can potentially provoke clinical symptoms and inflammatory response that may result in functional, structural, as well as other abnormalities such as altered haematological indices.[2,3]

Masons are among the group of workers affected by exposure to cement dust. Masons are workers who make use of cement powder as

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mortar in the laying of courses of bricks from one level to another.[4] The health outcomes due to exposure to cement dust among these group of workers include increased respiratory symptoms such as wheezing, chest tightness, cough and dyspnoea and these will eventually led to impairment in respiratory functions.[2,5] Workplace exposures to cement dust are strongly linked to an increased risk of chronic obstructive pulmonary disease (COPD) and chronic bronchitis which are often associated with emphysema and these have been reported as the most frequent respiratory diseases.[5-7]

Several studies have reported increased respiratory symptoms and reduced lung function in cement workers exposed to high concentrations of cement dust.[2,5,8] Findings from a cross-sectional study among cement factory workers in Port Harcourt, Southern Nigeria, revealed increased respiratory symptoms and reduced peak expiratory flow rate (PEFR) among the cement factory workers with 20.0% of the workers having chest pains and 14.3% having cough.[2] Mwaiselage et al in 2004 in Tanzania, found an annual decline in forced expiratory volume in one second (FEV_1) of 49.1ml and forced vital capacity (FVC) by 23.1ml for an average worker exposed to total cumulative dust levels of 28.9mg/m^3/year.[8] Also, a study by Siracusa et al in Italy found a linear decline of FEV_1 and FVC among cement workers who were checked in a follow-up study for 11 years.[9]

There is paucity of data with regards to the effects of cement dust on the respiratory system among mason workers in developing countries such as Nigeria. The exposures to cement dusts is even a larger problem in developing countries as personal protective equipment is often limited and even when available they are not used by workers.[10,11] In addition to compromising the health and safety of these workers, occupational health regulations and safety are often compromised.[5] Although some studies have been inconclusive with regards to cement dust being associated with reduced respiratory functions,[1,6] other studies have proved that there is increased respiratory symptoms and reduced ventilatory measures among workers exposed to cement dust compared to workers that are not exposed.[8,9]

The aim of this study was to determine the prevalence of respiratory symptoms and ventilatory functions among masons and office workers in Benin City, Nigeria, in order to ascertain the burden of respiratory diseases following exposures to cement dusts.

MATERIALS AND METHODS

This cross-sectional comparative study was carried out in Benin City the capital of Edo State, Nigeria from December 2014 to February 2015. Benin City is made up of three local government areas; Ikpoba-Okha, Oredo and Egor with a total population of 1,085,676.[12] As a result of rapid development and urbanization, the services of masons were being employed in many construction sites in the city.

The study population comprised of masons and office workers aged 18 years and above in Benin City. The office workers were drawn from the University of Benin. The masons were recruited from three pick-up locations (one in each of the three local government areas) selected by simple random sampling technique using balloting from the seven major pick-up locations in Benin City as at the time of the study. The pick-up location is where the

masons usually gather in the mornings before they are contracted to work in different construction sites. Only masons who work directly with cement and therefore exposed to cement dust were included in the study. Any mason or office worker with obvious clinical abnormalities of the vertebral column and thoracic cage, obstructive lung diseases and a history of recent chest or abdominal surgery were excluded from the study.

The sample size was calculated using a G*Power software version 3.1.7 (copyright(c) 1992 – 2013). The expected FVC mean (SD) values for the exposed and unexposed groups was 3.17 (0.6) and 3.42 (0.5) respectively, from a previous study in United Arab Emirates,[5] was utilized for the sample size calculation. A sample size of 78 exposed and 78 unexposed participants was calculated for this study to provide 80% power to detect the mean difference at the conventional 5% statistical significance level.

Data was collected using a validated researcher administered questionnaire and spirometry.

Questionnaire: The questionnaire used for this study was adapted from relevant sessions of the Burden of Obstructive Lung Diseases (BOLD) questionnaire.[13] Information was sought on the socio-demographic characteristics and respiratory symptoms of the respondents. The height and weight of participants were measured using Standiometer and standardized bathroom (Hana™) weighing scales. When measuring the height, the respondents were asked to stand erect with their feet together, heels, buttocks, shoulders and occiput touching the meter rule behind with eyes looking straight ahead. The body mass index (BMI) of the respondents was calculated using the formula: weight in kilograms over height in meters square. The BMI was then used to classify them as follows: underweight; BMI less than 18.5, normal weight; BMI of 18.5 – 24.9, over weight; BMI of 25.0 – 29.9, obese; BMI of 30.0 and above.[14]

Spirometry: This was performed according to the ATS/ERS guidelines,[15] using the Koko Legend spirometer model 314000 serial 2007 LB 0538. To ensure standardization, the spirometer was calibrated daily by a 3 litre calibrating syringe. The procedure for the ventilatory function test was explained individually to the respondents. A minimum of three and a maximum of eight reproducible tracings were obtained and the best were used as the final spirometric readings. The pulmonary function profile which includes FVC, FEV_1, PEFR, FEV_1/FVC and the percentage predicted values were recorded for each respondent. The FVC, FEV_1 and FEV_1/FVC ratio were used to classify the respondents as follows;[16] Normal spirometry: $FEV_1/FVC \geq 70\%$, $FVC \geq 80\%$ of predicted and $FEV_1 \geq 80\%$ of predicted. Obstructive impairments: FEV_1/FVC ratio that is <70%. Restrictive impairments: FEV_1/FVC ratio that is $\geq 70\%$, FVC and FEV_1, both < 80% of predicted.

Data Analysis: Data were analysed using SPSS version 16 software (SPSS Inc. Chicago, Illinois, USA) . The mean and standard deviation were used in characterising the age, anthropometric characteristics and pulmonary function parameters of the respondents. Frequencies and percentages were used in describing respiratory symptoms. The

student t-test for two independent samples was used to test the difference for the continuous variables between the two groups of respondents. The association between the prevalence of respiratory symptoms, ventilatory function impairments and occupation of the two groups of respondents was also assessed using chi-squared test. A p-value of less than 0.05 was considered statistically significant.

Ethical considerations: Ethical approval was obtained from the University of Benin Teaching Hospital Ethics and Research Committee. Permission to carry out the study was also obtained from the University of Benin. A written informed consent was obtained from each participant before conducting interviews and spirometric test. The respondents were health educated on the effects of cement dust on the lungs at the end of each day's interviews and spirometric tests. Respondents found to be ill were referred to the University of Benin Teaching Hospital for further investigations and management.

RESULTS

A total of 189 respondents comprising 98 masons and 91 office workers were interviewed. Of these, 150 (84 masons and 66 office workers) were able to carry out acceptable spirometric assessment according to the ATS/ERS guidelines. Table 1 shows that a greater proportion 44 (44.9%) of the masons were in the older age group of 60-69 years compared to the office workers 27 (29.7%) who were in the age group 30-39 years. The mean age of the masons was 57.3 (SD 11.3) years compared to 41.9 (SD 11.6) years of the office workers ($p < 0.001$). The mean height 166.0 (SD 8.4) metres of the office workers was slightly higher than that of the masons 165.0 (SD 7.8) metres, but this was not statistically significant ($p = 0.406$). There was a significant difference in the mean weight 77.2 (SD 14.3) kg and BMI 28.0 (SD 4.8) of the office workers compared to the masons 69.4 (SD 10.2) kg and BMI 25.7 (SD 3.6) [$p < 0.001$]. As regards the smoking status of the respondents, 27 (27.6%) of the masons were smokers compared to only 2 (2.2%) of office workers ($p < 0.001$).

Table 2 shows that a higher proportion 54 (55.1%) of the masons had spent more than 20 years on the job compared to the office workers 41 (45.1%) who had spent between 1-5 years on the job ($p < 0.001$).

Respiratory symptoms of cough 27 (27.6%), phlegm 26 (26.5%), wheeze 26 (26.5%), chest tightness 21 (21.4%) and dyspnoea 13 (13.3%) were significantly more prevalent among the masons compared to the office workers who had cough 5 (5.7%), phlegm 5 (5.7%), wheeze 4 (4.6%), chest tightness 3 (3.4%) and dyspnoea 1 (1.1%) respectively (Table 3).

Tables 4A and 4B shows the mean observed and percentage of predicted values of the ventilatory functions parameters of the respondents. The mean FVC of the masons 3.269 (SD 0.784) litres was slightly higher than that of the office workers 3.219 (SD 0.952) litres ($p = 0.725$) but the percentage predicted was significantly lower among the office workers ($p = 0.001$). There was no statistically significant difference in the observed and percentage predicted values of FEV_1 in both groups ($p = 0.104$ and 0.111 respectively). The observed and percentage predicted values of both FEV_1/FVC ratio and PEFR were significantly lower among the mason workers when compared to the office

Table 1: Socio-demographic and anthropometric characteristics of respondents

Variables	Masons (n=98) n (%)	Office workers (n=91) n (%)	P-value
Socio-demographic			
Age (years)			
20 – 29	0 (0.0)	16 (17.6)	
30 – 39	9 (9.2)	27 (29.7)	
40 – 49	15 (15.3)	21 (23.1)	
50 – 59	18 (18.3)	18 (19.8)	
60 – 69	44 (44.9)	9 (9.9)	
70 – 79	12 (12.2)	0 (0.0)	
Mean age (SD)	**57.3 (11.3)**	**41.9 (11.6)**	**< 0.001**
Sex			
Married	98 (100.0)	70 (76.9)	
Single	0 (0.0)	21 (23.1)	**< 0.001**
Educational status			
None	6 (6.1)	1 (1.1)	
Primary	66 (67.3)	26 (28.5)	
Secondary	26 (26.5)	22 (24.2)	
Tertiary	0 (0.0)	42 (46.20	**< 0.001**
Smoking			
Yes	27 (27.6)	2 (2.2)	
No	71 (72.4)	89 (97.8)	**< 0.001**
Anthropometric			
Height in cm			
Mean (SD)	165.0 (7.8)	166 (8.4)	0.406
Weight in Kg			
Mean (SD)	69.4 (10.2)	77.2 (14.3)	**< 0.001**
Body Mass Index			
Mean (SD)	25.7 (3.6)	28.0 (4.7)	**< 0.001**

Table 2: Respondents' duration of work

Duration of work (years)	Masons n (%)	Office workers n (%)	
1 – 5	7 (7.1)	41 (45.1)	
6 – 10	13 (13.3)	17 (18.6)	
11 – 15	13 (13.3)	5 (5.5)	
16 – 20	11 (11.2)	10 (11.0)	
> 20	54 (55.1)	18 (19.8)	
Total	**98 (100)**	**91 (100)**	
Mean (SD)	***24.6 (11.2)***	***12.1 (11.8)***	***p < 0.001***

Table 3: Respiratory symptoms of the respondents

Symptoms	Masons n (%)	Office workers n (%)	P-value
Cough	27 (27.6)	5 (5.7)	**< 0.001**
Phlegm	26 (13.3)	17 (18.6)	**< 0.001**
Wheezing	13 (13.3)	5 (5.5)	**< 0.001**
Chest tightness	11 (11.2)	10 (11.0)	**< 0.001**
Dyspnoea	54 (55.1)	18 (19.8)	**0.001**

Table 4A: Mean values of ventilatory functions parameters of the respondents

Parameters	Observed		P-value	Predicted (%)		P-value
	Masons	Office workers		Masons	Office workers	
FVC (litres)	3.269	3.219	0.725	89.3	80.1	**0.001**
FEV_1 (litres)	2.544	2.749	0.104	86.7	81.9	0.111
FEV_1/FVC	0.773	0.853	**< 0.001**	100.9	106.9	**< 0.001**
PEFR (litres)	6.105	7.142	**0.004**	77.9	86.6	**0.03**

FVC = Forced vital capacity; FEV_1 = Forced expiratory volume in one second; PEFR = Peak expiratory flow rate.

Table 4B: Mean values of ventilatory functions parameters of the Masons by smoking status

Parameters	Observed		P-value	Predicted (%)		P-value
	Smokers	Non smokers		Smokers	Non smokers	
FVC (litres)	3.119	3.274	0.407	83.9	85.5	0.672
FEV_1 (litres)	2.409	3.681	0.100	81.1	85.3	0.288
FEV_1/FVC	0.767	0.817	**0.009**	100.2	104.2	0.070
PEFR (litres)	5.772	6.727	**0.047**	73.2	83.5	0.050

FVC = Forced vital capacity; FEV_1 = Forced expiratory volume in one second; PEFR = Peak expiratory flow rate.

Table 5: Classification of respiratory status of the respondents

Classification	Masons n (%)	Office workers n (%)	P-value
Normal	57 (67.9)	38 (57.6)	0.194
Obstructive abnormality	17 (20.2)	5 (7.6)	**0.029**
Restrictive abnormality	10 (11.9)	23 (34.8)	**< 0.001**

workers. Among the masons, all the ventilatory parameters were lower in the smokers than the non smokers. However, only the differences in the observed FEV_1/FVC ratio PEFR showed statistical significance ($p = 0.009$ and 0.047 respectively).

The classification of the respiratory abnormalities seen in the respondents is shown in table 5. A higher proportion 17 (20.2%) of the masons had obstructive respiratory abnormality compared to the office workers 5 (7.6%) [$p = 0.029$]. On the other hand more office workers had restrictive respiratory abnormality 23 (34.8%) compared to the masons 10 (11.9%) [$p = 0.001$].

DISCUSSION

Most studies that have evaluated the association between prolonged exposure to cement dust and respiratory symptoms and reduced lung function were carried out among workers in cement manufacturing companies. However, this study which focused on masons who are the end users of cement, working without any form of personal protection, and are therefore exposed to cement dust, showed a much higher prevalence of respiratory symptoms and a corresponding lower pulmonary function indices among the masons when compared with non-exposed office workers.

The masons were significantly older than the office workers in this study. This finding may be as a result of the unskilled nature of the job of the masons as opposed to the office workers who being civil servants are required to retire when they attain the retirement age. Thus masons work for a longer duration of time until they are too old to work or could no longer work as a result of ill health. The resultant effect of this is prolonged exposure to cement dust which has been shown to result in respiratory symptoms and lung impairments.[2,5] A similar finding of a significantly younger population of exposed persons compared with controls have been reported in previous studies.[10,17] The prevalence of respiratory symptoms of cough, phlegm, wheeze, chest tightness and dyspnoea were significantly higher among the masons than the office workers This is consistent with findings from studies by Al-Naeimi et al[5], Mwaiselage et al[8] and Siracusa et al[9] in which there were significant increase in respiratory symptoms among the workers exposed to cement dust compared to the non exposed workers . This higher prevalence of respiratory symptoms among the masons is possibly due to long exposure to cement dust as majority of them had spent over 20 years on the job, and working without personal protective equipments. Prolonged exposure to cement dust has been linked to increase in respiratory symptoms due to irritation of the epithelium of the respiratory system as a result of the harsh components and minuteness of the dust.[2-4]

In this study, there was a significantly reduced lung function among the masons although the percentage predicted values of FVC and FEV_1 were lower in the office workers. This may be probably due to the combined effect of older age and prolonged exposure to cement dust when compared to the younger office workers. Although, it could not be ascertained if office workers may have been exposed to dust particles either in places of previous employment or in their place of residence, the proportion of smokers among the masons may have contributed to the lower lung function indices in this group. Among the masons, the lung functions parameters were lower in the smokers compared to non smokers.

Previous studies in Nigeria and other parts of the world have also reported lower FEV_1 among workers exposed to cement dust compared to the unexposed group.[2,5,10,18] Inhalation of cement dust irritates the airways and thus stimulates chronic low-grade inflammation over time. This will eventually result in reduced expiratory volumes as seen among the masons compared with the controls. A reduction in FEV_1 will lead to a corresponding reduction in other lung function parameters such FEV_1/FVC ratio and PEFR.

The prevalence of obstructive respiratory abnormalities was 20.2% and 7.6% for mason and office workers respectively. This was consistent with the observation that chronic obstructive pulmonary disease is associated with cement dust exposure and usually further aggravated by smoking.[1,2,5,7,18] On the other hand, restrictive lung abnormalities were more prevalent among the office workers. This was not surprising because the office workers had a slightly lower mean FVC compared with the masons. It was also observed that the weight and BMI of office workers were significantly higher than those of the masons. This finding is in contrast to findings from other studies in which the weight and BMI of the both exposed groups and controls were similar.[5,6] The higher weight and BMI among the office workers could be as a result of the sedentary nature of their work compared to the masons whose work is more energy demanding and physically exerting. Thus the restrictive lung abnormalities among the office workers may have resulted from the higher weight and BMI or other undetected medical conditions that are associated with restriction of the respiratory airways. This calls for the need to further assess the health status of office worker with special emphasis on the burden of respiratory diseases.

This study has the following limitations; first, the level of exposure to cement dust was not quantified as there was no measurement of cement dust in the work environment of the masons. Secondly, it was also not possible to explore the influence of smoking among the office workers because almost all of them were non-smokers. Finally, the study did not explore previous occupational exposures to cement dust among the office workers.

Conclusion: Masons have a higher prevalence of respiratory symptoms and reduced lung functions especially obstructive respiratory abnormalities when compared with office workers. Prolonged exposure to cement dust, smoking and non use of personal protective equipment are possible determinant of these findings. Therefore, local health authorities in Nigeria should be concerned about the health of masons by promoting health education on the health risk associated with prolonged exposure to cement dust and also ensure the use of personal protective equipment among masons while working. Further studies to quantify the concentration of cement dust in the work environment of masons and a follow up to determine the effect of reduction in lung function following prolonged exposure to cement dust are advocated.

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