COMPARATIVE STUDY OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE AMONG PRODUCTION AND ADMINISTRATION CEMENT FACTORY WORKERS IN PORT HARCOURT, NIGERIA

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ABSTRACT
BACKGROUND: *The cement industry has recently attracted a lot of attention owing to its phenomenal expansion and immense contribution to socio-economic development of Nigeria and especially Rivers State where many developmental projects such as construction of roads, building of houses etc are going on. Chronic obstructive Pulmonary Disease appears to be on the rise among workers in this endeavour. This study was to compare Chronic Obstructive Pulmonary Disease among production and administration cement factory workers in Port Harcourt, Nigeria.*

METHOD: *Following ethical approval 200 consenting respondents were recruited to represent production and administrative study groups via multi-stage sampling in this descriptive cross sectional study. Data were collected using structured close ended questionnaires, a checklist for walk through survey, spirometry and dust level metre. Data were later entered and analyzed with SPSS version 19 and presented using descriptive and analytical statistical tools.*

RESULT: *Chronic Obstructive Airway Disease (COPD) was 36% (and statistically significant 0.004) higher among production (operations staff) than the 18% in administration staff of the cement company. The disease was also higher among respondents above 40 years, male and longer exposure.*

CONCLUSION: *COPD among workers in this cement factory was high among the production (operations) group than the administration group. It is recommended that health education on COPD be intensified among workers just as production and enforcement of Personal Protective Equipment is maintained.*

Key words: *Chronic Obstructive Airway Disease, workers, cement*

INTRODUCTION

Occupational diseases contribute significantly to the rising burden of non-communicable disease in the world, thus causing huge suffering and loss to families and national economies.[1,2] The International Labour Organization (ILO) has described occupational diseases as diseases that have a strong causal relationship to occupation and arise mainly from exposure to hazards in the workplace.[3] An estimated 2.34 million people die each year from work-related accidents and diseases and of this, 86% of them die from work-related diseases alone.[2,4,5] Despite the alarming statistics, occupational health problems continue to receive low priority on national health agenda.[4,5]

Within the West African sub-region, rapid industrialization with poorly regulated work processes have further worsened work related outcomes.[6] Respiratory diseases specifically have become increasingly important as a result of excessive production of dust from many industries.[7-9] Workers in the cement, quarry, wood mills and mining industries have been reported as the most adversely affected.[10-15] The cement industry in particular has attracted much attention in recent times because of its phenomenal expansion and immense contribution to socio-economic development. In Nigeria and especially Rivers State, many developmental projects such as construction of roads, building of houses and industries are on the increase.[16]

The demand for cement has been on the increase due to a rise in construction of roads, bridges, drainages, concrete platforms, electric columns, water ways, dams and jetties. The cement dust generated from these operations has been shown to have deleterious health consequences.[17,18] Various acute and chronic respiratory effects have been reported with different grades of lung function impairment.19-20Lung function impairments are measured mainly with peak flow meter and spirometer but the latter has been shown to be more sensitive in detecting changes in lung functions.[21] Among the various measures, FEV1 and FVC are the most widely utilized. Values of individual measurement, falling below the fifth percentile of predicted are considered abnormal.[21] Over time, permanent impairment in lung functions with FEV1/VC ratio less than 80% which is indicative of chronic obstructive pulmonary disease (COPD) may arise.[22]

Occupational exposures are assuming a more prominent role in the development of COPD as compared to other risk factors.[23-25] Work potentiates the severity of the disease, accelerates the rate of lung function decline and further worsens the disability among those who have the disease.[26-29] In addition, the risk of acquiring respiratory diseases in the cement industry has been shown to be dose dependent,[30] adversely affecting workers who are directly involved with production and bagging as compared to office workers.[30-32] However, COPD like many occupational diseases may not be diagnosed until years after the worker has left the work environment. The effects are often irreversible with grave consequences.[33-34] Therefore, prevention remains the most important factor in the control of occupational health diseases.

Globally, occupational exposures contribute 15% of all COPD.[35-38] The World Health Organization in a comparative risk assessment further showed that COPD is the third leading cause of occupational disorders and the second leading cause of occupational deaths globally.[39] Also, in a report from Nigeria, Omokhodion listed COPD (chronic bronchitis) as a common yet unreported occupational health problem.[40] In addition, it has been estimated that two-thirds of workers globally may be exposed to hazards that clearly exceed the standard occupational exposure limits.[5] Reports from Nigeria showed that factory workers often work in environment where dust levels are well above the accepted threshold limit value.[41-42] Also, these workers are often employed without appropriate hazard management training and are left to work without adequate provision of standard personal protective equipment thus increasing the risk of developing occupational diseases.[22,41] Thus, the World Bank, WHO and leading respiratory bodies have accentuated the need for urgent preventive action to reverse the trend of occupational diseases.[2,5,23,38] However, despite this call, occupational diseases still constitute a huge public health challenge.[4,40] The need to implement cost-effective workplace control measures is therefore pertinent to curb this fast rising "hidden" epidemic.

The prevalence of COPD is grossly underestimated and diagnosis is usually made when clinical manifestations are apparent with advanced disease.[33] Usually, mild respiratory symptoms go unnoticed but as symptoms progress, quality of life is compromised resulting in frequent exacerbations and hospital visitations.[33] Symptoms of COPD are often indistinguishable from other chronic respiratory ailments like asthma and tuberculosis and are often erroneously attributed to such.[33] This is because, these diseases share similar respiratory symptoms such as cough, phlegm, dyspnea, wheezing and chest pain.[33]. The GOLD diagnostic criteria consider respiratory symptoms as the first level in diagnosis of COPD.[43]

A cross sectional study was done in UAE to determine the prevalence of chronic respiratory symptoms, lung function impairment and the use of personal protective equipment among workers at a Portland cement factory.[44] The study group consisted of workers exposed to dust, while the comparison group consisted of workers occupationally unexposed to dust. The findings showed that 36% of the exposed workers had lung function impairment as compared to 10% of the unexposed workers.[44] Also, a cross sectional study done in Jos, Nigeria on prevalence of respiratory symptoms among cement loaders, the finding was similar.[45] These finding are essentially similar with studies in Pakistan among brick kiln workers and cement workers in Morocco[44,45].

Prevalence estimates of COPD show significant variability across populations, suggesting that risk factors can affect populations differently.[38] Risk factors implicated in the development of COPD include: occupational exposures, indoor air pollution from biomass fuel, other respiratory diseases, smoking and outdoor air pollution.[24, 46] In the Asian continent, 11 countries were used to estimate the prevalence of COPD. The prevalence was estimated to be 6.3% with significant inter country variations ranging from 3.5% in Hong Kong and Singapore to 6.7% in Vietnam.[46] In this region, indoor air pollution from use of biomass fuel during cooking is a predominant variable for the women. In the European region, several studies have found a measured prevalence of COPD between 4% and 10% of adults.[48,49] A population based study in Spain showed the prevalence of COPD to be 9.1% with a male to female ratio of 14.3 and 3.9% respectively.[48] In a study in England, there was marked intra country variation with the highest area having a prevalence of 18% and the lowest area 4.9%.[48] In another study in England, COPD prevalence was 10% in an area with past history of heavy industrial activity.[49] This may have accounted for the higher prevalence rate found in this region. The study also found significant associations among individuals who worked with certain industries, underscoring the importance of occupational exposure in the development of disease. Similarly, a community-based study of 81 countries in the United States reported a significantly increased prevalence of COPD among dust-exposed workers. In another study done in Ife among urban residents, the prevalence of COPD was found to be 7%.[50] This was similar to another study among residents in an urban area in Lagos, where the prevalence of COPD was found to be similar for men with a rate of 7.6% (95% CI 4.1 – 12.6).[51]

This was a comparative study of chronic obstructive pulmonary disease among production and administrative workers in a cement factory in Port Harcourt Nigeria.

MATERIALS AND METHODS

Study Area: Rivers State, South-South, Nigeria has 23 Local Government Areas with its capital being Port Harcourt with a total population of Rivers State is 5,198,716.[52] The people are mainly farmers, traders and civil servants. The capital Port Harcourt is cosmopolitan with many large and small scale industries and several learning institutions. The major large scale industries include oil and gas related companies, banking industry, construction and educational institutions. There are four major cement companies in Rivers State (viz Dangote, BUA, Ibeto and Atlas cement companies) engaged in production, bagging and distribution of cement to marketers and end-users. Port Harcourt has an international airport and a major seaport facilitating world human traffic and trade of diverse products. The seaport serves as a major means of importation of cement - related products.

Study Design and population: This was a comparative cross-sectional study among operational and administrative cement factory workers. The study group consisted of operational workers directly exposed to cement dust while the comparison group was drawn from workers with low dust exposure in the administrative section. The study was carried out in two cement factory sites located in Port Harcourt City and Eleme Local Government Areas of Rivers State.[96] The factories have an average of 388 and 212 full time workers respectively. The departments in the cement factories are broadly classified into administrative and operational sections. The administrative unit comprises mainly personnel, marketing, clerical, security, clinical and other logistic staff. The operational section broadly classified into production, manufacturing and maintenance units comprises of workers directly exposed to dust and includes workers in the bagging, crushing and packing section; loaders, mechanical engineers, technicians, and other support staff in the methods department.

Inclusion criteria: All categories of workers in the cement factory that had worked for a minimum of two years were recruited. However, current or past smokers, past history of tuberculosis, workers in administration but had previously worked in operations were excluded. Also, workers with previous history of abdominal or chest surgery or even vertebral column abnormalities may not perform test maneuvers properly and may compromise validity of results obtained and so were excluded.

Sample size and sampling technique: The formula for calculating sample size for the comparison of two proportions was used to arrive at a sample size of 200 respondents including allowance for non-response. Sampling was multistage where first two cement factories were balloted for among the four major cement companies. Atlas cement (Lafarge) and Ibeto cement factories were therefore selected.

Then, stratified sampling technique using proportional allocation was used to select the study participants. A list of all the workers in the various departments of the factory was obtained from the Human Resources Department. Workers were grouped broadly into the operational exposure group or the unexposed administrative group based on a job exposure matrix and earlier working definition of these two groups above. The workers in the operations were further grouped according to the existing sub-departments which included: manufacturing (crushing, kiln), production (bagging, loading), maintenance, methods (logistics and marine operations). A list of workers in each stratum was obtained from the various heads of department. Proportional allocation was used to determine the number of workers to be selected from each department. Thereafter, simple random sampling using a table of random numbers was used to select the participants in each stratum using the sampling frame. Ditto, for the Administrative group as workers in this group were sub- divided into the welfare department, health assistants, security men, clerical workers, and workers in the personnel department.

Study Instruments: The study instruments used comprised, observational checklist, questionnaire, spirometer and dust level meter. **Questionnaire** was structured; interviewer–administered and adapted from the questionnaire on respiratory symptoms (1986) approved by the British Medical Research Council's Committee on Environmental and Occupational Health. The questionnaire was modified to suit the research objectives as it probed socio-demographics, occupational history, respiratory symptoms and utilization of control measures among cement factory workers. **The Observational checklist:** applied via a walk-through survey of the cement factory sites to ascertain the potential health hazards, groups at risk and levels of exposure of hazards especially those that affect the respiratory system. The various control measures in place were observed and gaps in utilization were also assessed using an observational checklist (See appendix1). Engineering controls, use of PPEs and other adjunct methods of control of hazards were ascertained.

Spirometer: Spirometric measurement was performed using a calibrated flow sensing portable Spirometry, Contec[tm] compact II Spirometry model SP100. Respondents $FEV_{1\%}$, FVC, FEV_1, and PEFR were measured. Spirometry was used to assess lung functions in accordance to the widely accepted 1987 American Thoracic Society criteria[22] (see procedure for examination under data collection).

Dust level meter: Dust level in the cement factory was estimated using the Control of Substance Hazardous to Health limit of $10mg/m^3$. The dust level meter model SKC 261 secca med USA uses the principle of photoelectricity. These measurements were carried out with the assistance of an environmental biologist over a five day period at the operational and administrative section of the factory sites.

Pre-testing of the study instruments: To ensure validity and ascertain the length of time required for administration of questionnaires, 10% (20) of the questionnaires were pretested (in a similar cement factory) as some questions were re-phrased and the average length of time for each respondent was ascertained. The functionality of the spirometer was also pre-tested according to the manufacturer's instruction.

Training of research assistants: For the purpose of this study, six research assistants were trained for an average of four hours for four consecutive days on data collection using the various study tools. Five nurses were trained on spirometric examination and administration of the questionnaire while an environmental biologist assisted with the dust level assessments. The operational definition of COPD was based on Global Initiative for Chronic Obstructive Lung Disease (GOLD) working group criteria. Forced expiratory volume in 1 second (FEV_1)/forced vital capacity (FVC) less than 70 percent and FEV_1 less than 80 percent predicted will be considered as COPD.[71] In addition cases of COPD were appropriately referred to a consultant pulmonologist of UPTH for further respiratory evaluation.

Data Collection: The following data were collected quantitatively viz: Occupational history, respiratory symptoms and utilization of control measures using a structured questionnaire, existing control measures collected using an observational check list, quantitative measurement of dust levels in the cement factory and status of lung function of the workers determined using a spirometer.

Data management: The variables measured included: prevalence of COPD, prevalence of respiratory symptoms, dust level and utilization of control measures. Data was entered and analyzed using statistical package for social science (SPSS) version 19. Descriptive and analytical tools were further used in analyzing and presenting results.

Ethical Consideration: Ethical clearance was obtained from the Ethical Committee of the University of Port- Harcourt Teaching Hospital before the study commenced. Permission to conduct the study was obtained from the management of the factory, as well as informed consent from participants. Anonymity was maintained using research numbers as an alternative to names and all clients were made aware of their right to withdraw from the study at any time. The purpose and benefits of the study were explained accordingly.

Limitations: In occupational settings, healthy worker effect may affect the true prevalence rate of respiratory diseases as workers with severe form of the disease may have left the company or died. Walk through survey of the second cement factory could not be concluded due to security challenges and ongoing internal crises in the company.

RESULTS

Table 1: Socio-demographic characteristics among workers in the cement factory

Variables	Operation N = 100 n (%)	Administration N = 100 n (%)	Test statistic χ^2	p –value
Age (years)			2.88	0.09
40 and above	55(55)	43(43)		
Less than 40	45(45)	57(57)		
Mean age ± SD	40.07±10.7	37.9±11.9	1.38**	0.17
Sex				
Male	98 (98)	92 (92)	3.79	0.05
Female	2 (2)	8 (8)		
Marital status				
Single	15 (15)	22 (22)	1.62	0.20
Married	85 (85)	78 (78)		
Educational level				
None	18 (18)	9 (9)	10.68	0.01*
Primary	0 (0)	7 (7)		
Secondary	50 (50)	46 (46)		
Tertiary	32 (32)	38 (38)		

**Independent T test   *statistically significant

Table 2: Prevalence of respiratory symptoms among operational and administrative groups**

Respiratory symptom	Operational N = 100 n (%)	Administrative N = 100 n (%)	x^2	p value
Cough	60(60)	37(37)	10.59	0.001*
Wheezing	16(16)	10(10)	3.757	0.153
Sputum	16(16)	4(4)	8.00	0.005*
Chest pain	39(39)	23(23)	5.98	0.014*
Breathlessness	30(30)	17(17)	7.08	0.069
Chest tightness	36(36)	19(19)	8.22	0.004*
Cough blood	8(8)	1(1)	6.63	0.021*

* Significant at $p < 0.05$ Multiple re sponses apply *

Table 3: Lung Function Indices among operational and administrative workers

Variable	Operation N= 100 Mean ± SD	Administration N= 100 Mean ± SD	T- test	p - value
FEV_1%	69.9 ±13.6	80.1 ±16.3	1.496	0.04*
FVC	61.9 ±13.4	63.4 ±14.8	0.789	0.501
FEV_FVC	1.09 ±0.09	1.11 ±0.12	1.464	0.145
PEFR	80.20 ± 9.0	81.26 ±8.7	0.27	0.03*

* Statistically significant

Table 4: Lung function indices among respondents more than forty years of age

Lung Indices in respondents aged above 40 years	Operation n = 100 Mean ±SD	Administration n =100 Mean ±SD	t test	p value
FEV_1%	70.3±14.7	78.0±16.5	1.161	0.024*
FVC	60.8 ±13.9	63.4±15.7	0.83	0.409
FEV_FVC	1.09±0.08	1.11±0.14	0.79	0.432

*statistically significant

Table 6 above shows that among the workers aged 40 years and above, lung function indices were lower among workers in the operational group as compared to workers in the administrative group. This difference was statistically significant for FEV_1% at $P \leq 0.05$.

Table 5: Lung function indices among respondents less than forty years of age

Lung Indices in respondents ≤ 40 years	Operation n = 100 n (%) Mean ±SD	Administration n =100 n (%) Mean ±SD	t test	p –value
FEV_1	67.4±12.90	70.2±16.30	0.97	0.07
FVC	62.6±13.10	63.5±13.90	0.34	0.72
FEV_FVC	1.08± 0.09	1.10± 0.09	1.22	0.27

Operational workers who were more than forty years old had lower lung function values than workers in the administrative section. This difference was not statistically significant for any of the measured lung function indices across the groups.

Table 6: Lung function values of respondents more than ten years in employment

Variable	Operation n = 100 n (%) Mean ±SD	Administration n= 100 n(%) Mean ±SD	t test	p - value
FEV	65.6±14.8	68.6±16.4	0.96	0.34
FVC	60.0 ±14.1	62.1 ±15.5	0.83	0.48
FEV_FVC	1.10 ±0.07	1.11 ±0.14	0.79	0.52
PEFR	90.5 ±14	97.8 ±0.60	4.43	0.00*

*Statistically significant

Table 7: Lung function values of respondents less than ten years in employment

Lung function indices	Operations N =100 n (%) Mean ±SD	Administration N =100 n (%) Mean ±SD	t test	p – value
FEV	61.9±12.8	72.4±16.1 0	1.49	0.14
FVC	63.3±12.8	65.4±13.8 0	0.8 0	0.43
FEV_FVC	1.08±0.09	1.11±0.09	1.41	0.16
PEFR	96.7±41	97.06±9.35	0.28	0.77

The lung function test showed higher values among workers in the operational as compared to the administrative group that had worked for less than ten years. FEV, FVC, and FEV/FVC ratio parameters were more reduced in the operational than in the study group. These differences were not statistically significant.

Table 8: Mean FEV of workers across various departments in the factory

Department	Mean FEV	Confidence interval
Administration	83.3 ±10.0	76.1, 90.4
Maintenance	70.6 ±16.7	60.0, 81.2
Manufacturing	69.71 ±14.8	65.4, 74.0
Methods	67.5 ±18.63	47.9, 87.1
Packing	66.9 ±13.65	64.2, 69.6
Production	65.7 ±18.84	57.5, 73.8

Table 8 above, shows comparison of lung function test results of the workers in the different work strata. The administrative section recorded the highest value for FEV (83.3%). Among the operations, the maintenance section had the highest mean FEV value (70.6%), while the lowest value was seen among workers in the production department (65.7%). The mean FEV for all the departments were within the limits of the confidence interval, and none of the intervals contained the null value of one.

The mean FEV of workers in the packing, production, maintenance, administration and methods section were determined and the 95% confidence interval was used to test for significance of the mean values.

Table 9: Prevalence of COPD among operational and administrative workers

COPD	OPERATION N = 100 n(%)	ADMINISTRATION N =100 n(%)	TOTAL N =200 n(%)	TEST STATISTIC χ^2	p-VALUE
Present	36 (36)	18 (18)	54	8.2	0.004*
Absent	64 (64)	82(82)	146		

*Statistically significant

Table 10: Risk factors of COPD among operational and administrative workers

*statistically significant ** Fishers exact test

Variable	Operational N=100 n (%) Present	Administration N=100 n (%) Present	χ^2	P value
Age				
≥40 years	27(61.4)	18(46.2)	1.03	0.31
< 40 years	17 (38.6)	21 (53.8)		
Sex				
Female	2 (4.5)	0 (0)	0.99**	0.32
Male	42 (95.5)	39 (100)		
BMI(kg/m^2)				
<30	19 (43.2)	27(69.2)	0.04	0.83
≥30	25(51.8)	12(30.8)		
Work duration(years)				
>10	44(62)	35(44.3)	0.4	0.51
< 10	27(38)	44(55.7)		
Source of cooking fuel				
Biomass fuel	33(75.0)	29(74.4)	19.4	0.001*
Others	11 (25.0)	10 (25.6)		

Table 14: Predictors of risk factors of COPD among cement factory workers

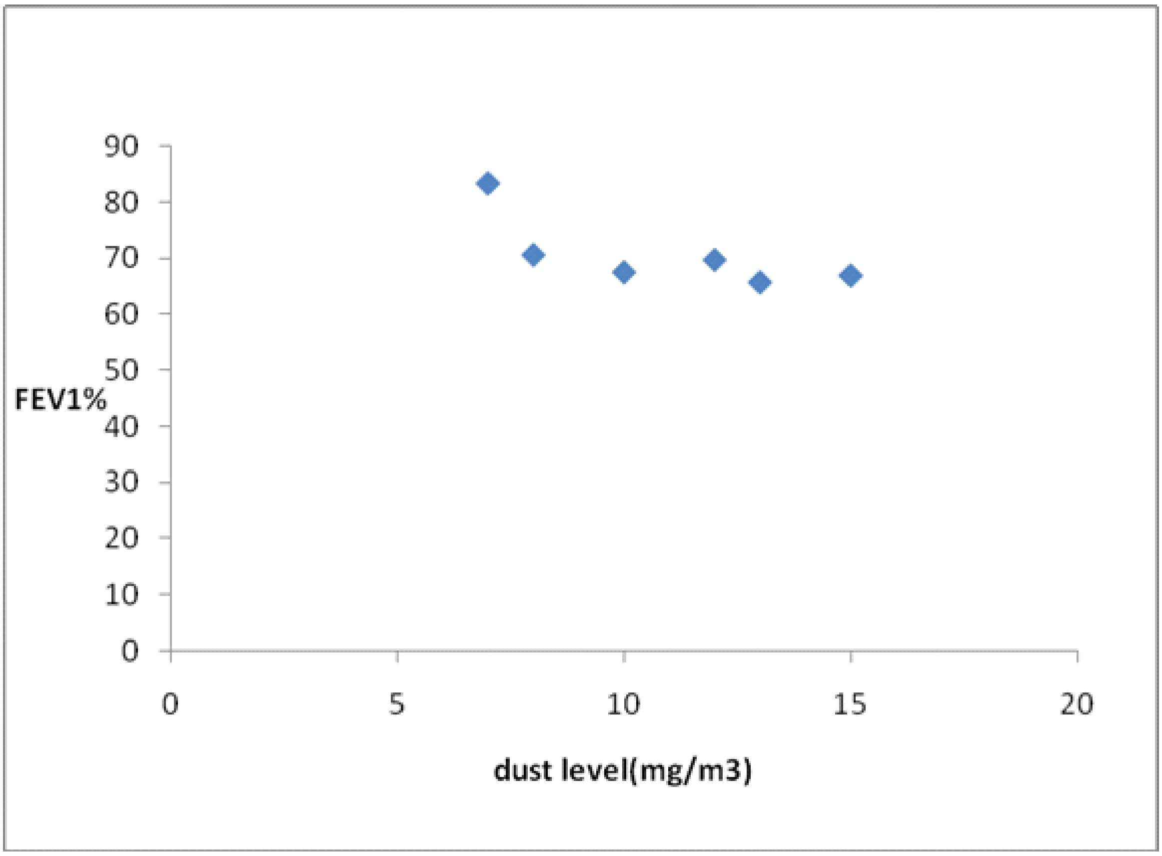
variable	P	OR	95% Confidence interval
Exposure status	0.55	1.20	0.66, 2.16
Work duration	0.15	0.455	0.18,1.32
Source of fuel	0.027	2.085	1.09, 4.00
Age category	0.049	2.667	1.01, 7.07
Sex	0.092	4.267	0.78, 23.09

Following bivariate analysis, multivariate analysis was carried out for risk factors in workers who had COPD. Work duration, source of fuel, age category and sex were entered into the logistic regression model. Source of fuel and age of respondents were the major factors found to predict the prevalence of COPD. Workers that use biomass as the principal source of fuel were two times more likely to develop COPD than workers who use other sources of cooking fuel. This difference was statistically significant (P= 0.027). Similarly, workers above 40 years of age were nearly three times more likely to develop COPD than workers less than 40 years of age. This difference was statistically significant (P=0.049). Males were four times more likely to develop COPD than females probably due to the higher number of males that work in the operational section of cement factories as compared to women. This difference was not statistically significant.

Table 15: Assessment of Dust Levels at Operational and Administrative Factory Sites

Dust Level (mg/m^3)	Operation (mg/m^3)	Admin (mg/m^3)	t-test	P Value	Reference Value (COSH)
Mean ± SD	11.6	5.4	4.871	0.001	10.0mg/m^3
Range	5 - 7	8 - 17			

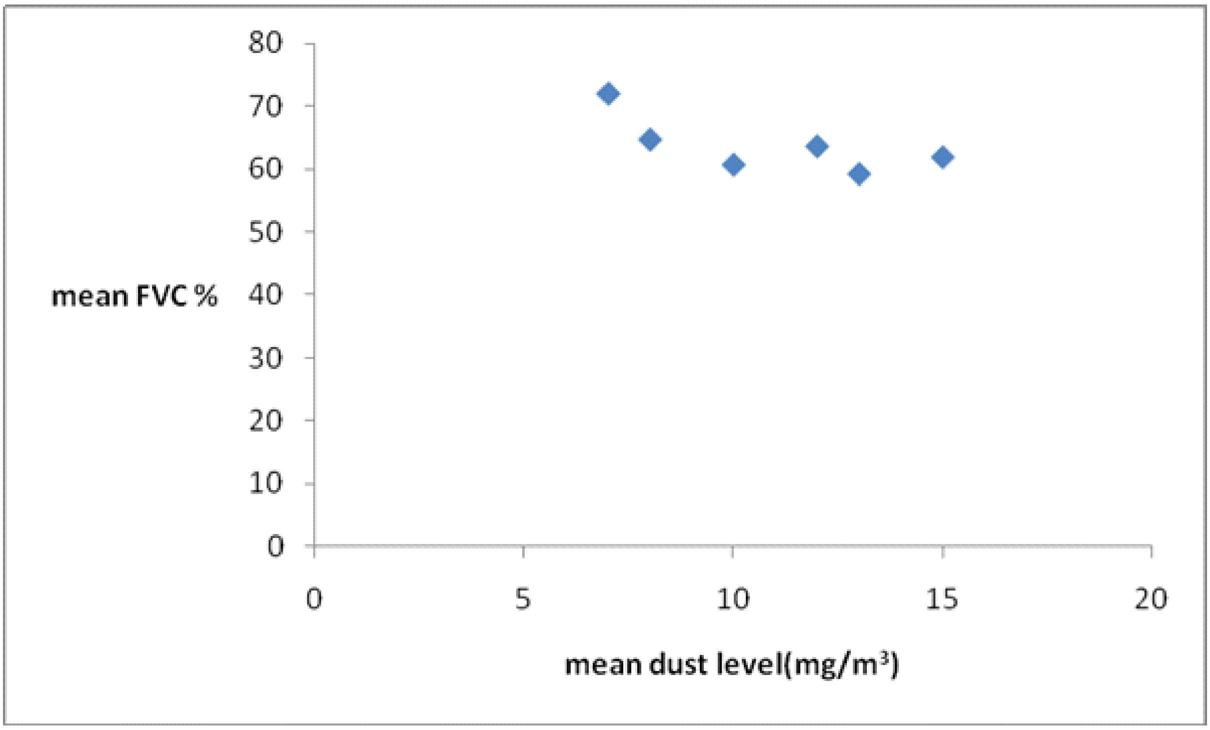
Table 15 above shows the estimation of the dust levels at the various work sites. Dust was measured at the packing, manufacturing, administration, maintenance, methods, and production areas. The mean dust level in the administrative section was 5.4mg/m^3 while the mean dust level in the operations was 11.6mg/m^3. The dust level was highest in the packing section (15mg/m^3) and lowest in the administrative section (5mg/m^3).



(r = - 0.7, P = 0.001, r^{2} = 45%)

Figure 1: Relationship between mean dust level and mean FEV of workers in various departments of the factory

Pearson's correlation coefficient was used to determine the relationship between mean dust levels and mean FEV. From figure 1 above, there is a moderate and negative linear relationship between dust levels and FEV(r=-0.7). As dust level increases across departments, mean FEV of workers in those departments also decreases. This association was statistically significant (p= 0.001). The coefficient of determination (r^2) was 45%.



(r = -0.77, p= 0.01, r^2 =50%)

Figure 2: Relationship between mean dust level and mean PEFR among workers in various departments of the factory.

From figure 2 above, there is a strong and negative linear relationship between mean PEFR and departmental dust levels. As dust levels increases across departments, mean PEFR of workers in those departments also decreases. Fifty percent of the observed change in FEV is likely to be due to an increase in dust level (r^2 = 50%).

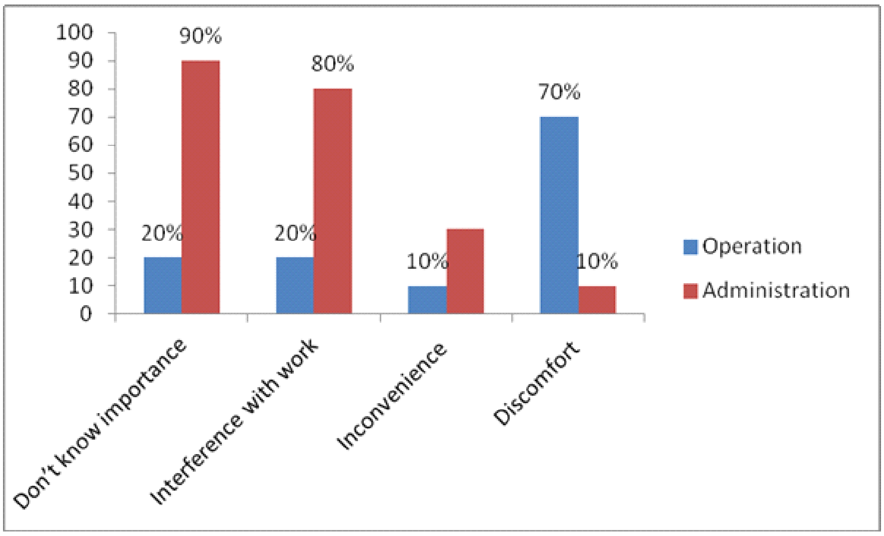
4.8 ASSESSMENT OF UTILIZATION OF CONTROL MEASURES AMONG WORKERS IN THE CEMENT FACTORY

Table 16: Comparison of utilization of PPE among operational and administrative cement factory workers**

Type of PPE	Operation N=100 n(%)	Administration N=100 n(%)	OR	C.I	χ^2	P value
Eye goggles	98(98)	85(85)	8.64	1.92-38.89	10.86	0.009*
Helmet	98(98)	92(92)	4.26	0.80-20.59	3.78	0.05*
Hand gloves	94(94)	91(91)	1.54	0.53-4.53	0.648	0.42
Safety boots	98(98)	92(92)	4.26	0.88-20.59	3.78	0.05*
Face mask	92(92)	86(86)	1.87	0.74-4.68	1.838	0.17

Statistically significant * Multiple responses apply**

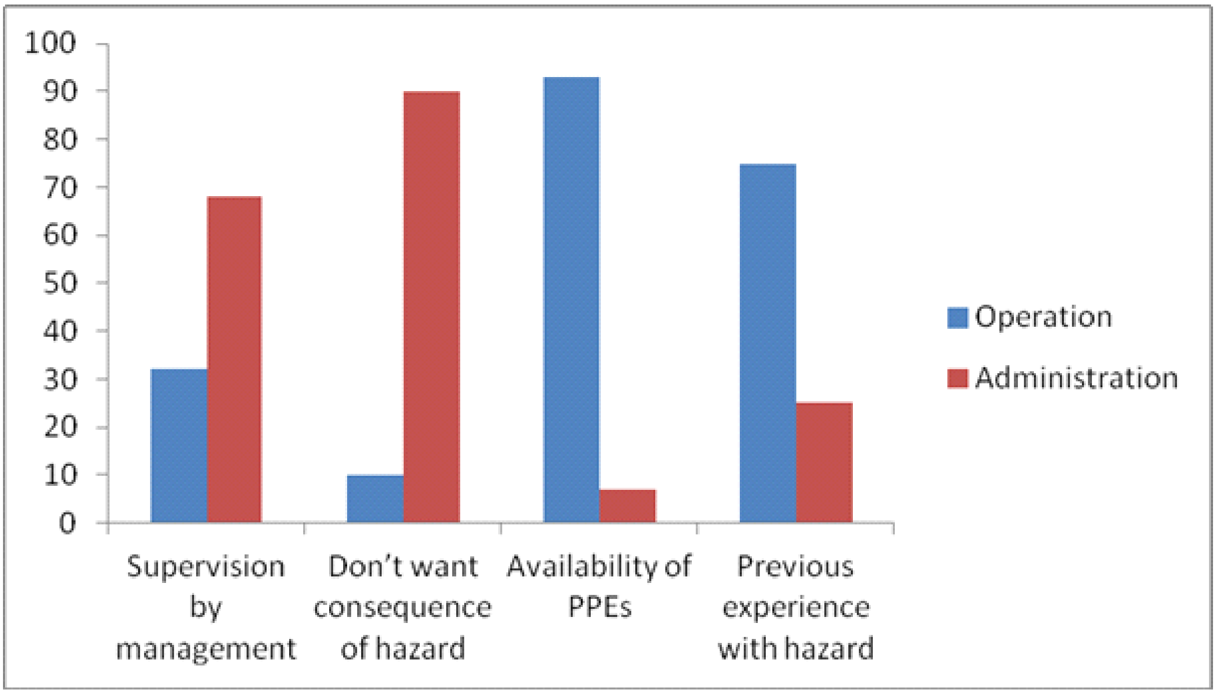
Commonly utilized PPE mentioned by respondents in the cement factory included: eye goggles, helmet and safety boots and face mask. Eye goggles, helmet and safety boots were the most utilized devices among the operational group (98%), with face mask being the least utilized (92%). In the administrative group, helmet and safety boots were the most utilized PPE (92%), with eye goggles being the least utilized (86%). The difference was statistically significant for eye goggles, helmet and safety boots.



(2= 3.0, p= 0.09)

Figure 3: Reasons for poor utilization of PPE among workers

Factors responsible for non utilization of PPE were assessed. The most common reason for not using PPE among the operational group was discomfort as reported by 70% of respondents. This was different from that of the administrative group, where discomfort was the least reported reason (10%). Majority (90%) of the workers in the administrative section did not use PPE because they didn't know the importance as against only 20% in the operations who didn't use PPE because they didn't know the importance.



(P =0.1, ^{2}=6.7)

Figure 4: Factors encouraging PPE use among factory workers

Factors such as supervision and enforcement by management, availability of protective devices, prior experience with hazard and prevention of hazards positively influenced use of PPE among factory workers. For workers in the operational group, availability of PPE and previous experience with hazards were major reasons for using PPE (90% and 71% respectively). For the administrative group, only a small proportion of workers (6.5% and 27%) used PPE because they were available or they had a previous experience with a hazard. Rather, supervision by management and knowledge of consequence of hazard were the main reasons for using PPE (68% and 89% respectively).

Table 17: Correlation of PPE use and Respiratory symptoms among Operational and Administrative workers in the cement factory

Respiratory symptom	Operational N=100 n(%)		Administration N=100 n(%)		MH(x2)	P value	MH OR
	PPE use	PPE non use	PPE use	PPE non use			
Cough						P<0.00001	0.24
Yes	20	30	17	44	19.47		
No	40	10	20	19			
Sputum production						0.05	0.24
Yes	20	6	2	2	3.60		
No	64	10	94	2			
Wheezing						0.001	0.05
Yes	1	4	2	3	25		
No	83	12	88	7			
Chest pain					1.86	0.17	3
Yes	60	38	75	20			
No	1	1	2	3			
Breathlessness							
Yes	2	3	2	3	19.4	0.001	
No	68	27	81	14			

Cough and breathlessness were the most common respiratory symptoms (40% and 27%) experienced by non- users of face mask in the operational group while cough and chest pain were more frequent among non users of face mask in the administrative group (20% and 23% respectively). The least symptom experienced by non- users of face mask in the operational group was chest pain (1%) followed by sputum production (10%) while that of the operational group was wheezing and sputum production (2% and 3% respectively). Using face mask was protective for most respiratory symptom except for chest pain where the odds was three times higher among users of face mask than non users of face mask.

WALK THROUGH SURVEY OF ATLAS CEMENT FACTORY PREMISES

An assessment of the work environment and work process of the cement factory sites were carried out to determine the groups at risks for work hazards, the potential for exposure and the existing control measures to protect the workers from risks associated with hazards. The hazards were assessed according to the classification of the work environment such as: physical, chemical, biological, ergonomic, and psychosocial exposures.

A walk through survey was carried out in Atlas cement company located at Eleme local government area of Rivers State. The cement factory with an average number of 388 workers was adequately sited as it was not in close proximity to the community. The departments in the cement factories are broadly classified into administrative and operational sections. Majority of the workers in the operations section are engaged in shift work which covers an eight hour period over five to seven days. The daily activities are supervised by unit heads who report to the management of the company. Cement products are transported through ocean carriers to the company's jetty. The cement is then transported through the conveyor belt system into a silo. From the silo, it is conveyed to bagging lines and carriers. The company has a large dealership network extending to all states of the South-South and South-East geopolitical zones of Nigeria and the Federal Capital Territory.

Strict access control was observed at the main gate located some distance away from factory. The administrative section of the factory resided in a different area from the operations.

Entrance into the operational area was also regulated. An onsite supervisor was present to ensure PPE were adequate and correctly worn. Safety boots, goggles, helmets, reflector jackets, face masks, and overalls were mandatory requirements for entering hazardous sites. However, some workers were seen hanging face masks on their bodies without using them. The reason given for this action was discomfort and interference with job processes from PPE use. Before further entry was granted, the company's health, safety and environment officer went through the company's safety regulations for a few minutes. IEC materials were pasted boldly on the walls of the company.

Visible dust was not seen in the administrative area but it was found at the packing, production and crushing areas. Fumes were also seen in the kiln areas. Workers in the kiln areas were seen wearing reflective jackets to reduce the impact of emission of heat from work process. All the workers in affected areas were seen wearing face masks to prevent inhalation of dust. Workers were seen wearing ear plugs to reduce the exposure to noise from automated machines.

Good housekeeping was generally observed. No liters or indiscriminate disposal of waste was observed. Waste bins were seen at major entrances; however, waste was not segregated before disposal. Taps for fetching water were present to enhance good housekeeping. A restaurant was cited within walking distance but away from work areas. No visible rodents were seen around the premises. Sanitary facilities such as toilets, bathrooms, and changing rooms were seen at the various sections. These rooms were not adequately maintained as water and waste papers were seen on the floor.

A health clinic comprising of a doctor on retainership, four nurses, and several health assistants was seen and functional. However, disease management guidelines were not seen and adequate health records were not kept. In addition, a system for reporting occupationally notifiable diseases was non- existent.

The areas with hazardous processes were cited far from the other areas of the company and enclosed and sharp or dangerous parts of machines were enclosed. Permit to work, which is a document showing authorization to enter dangerous places, was required for access into such sites. Dust control was done using dust expellers such as dust control machines. However, one of the machines had not been serviced and was observed to have broken down, hence the presence of dust in the air. Wet drilling was another dust reduction measure observed onsite. Blowers were used by workers at the end of the work process to remove accumulated dust from their clothes.

At the end of the walk through survey, preliminary results of the survey were communicated to the health officers and management of the factory. Health education was done for the workers and planning for further meetings is still on- going.

DISCUSSION

The socio-demographic characteristics of respondents showed that the mean age of workers in the operational group was 40.07±10.7 years while that of the workers in the administrative group was 37.9±11.9 years. This was slightly different from a study carried out in a cement factory in Northern Nigeria where the mean age for workers in the operational section was 35.3±7.5 and 32.2±6.5 years in the unexposed group. The male preponderance observed among the factory workers is in keeping with studies carried out by Douglas and Alasia as well as Merenu in cement factories in South-South and North-West Nigeria respectively.[20,32] However, this male dominance was also seen in the administrative section that had less physically demanding tasks and may be a reflection of the gender bias seen in many organizations in our environment. Majority of respondents in this study had secondary education, which is comparable to Douglas and Alasia's study.[32] This finding may not be unconnected with the early recruitment of community members in fulfillment of company's corporate social responsibility.

Respiratory symptoms were assessed among factory workers based on self reporting of symptoms. The prevalence of respiratory symptoms in this study was higher in the exposed who comprised of workers in the operations than in the unexposed workers from the administrative group. Cough was the most frequently occurring symptom in both the exposed and unexposed group with higher values recorded for the exposed. The frequency of cough obtained from this study is comparable to findings from a study by Akanbi and Ukoli in 2010 in Jos, Nigeria to determine the prevalence of respiratory symptoms among loaders of cement in the factory compared to a group from a tertiary institution.[45] However, the prevalence of cough in the index and the aforementioned studies were much higher than that of other international studies done in United Arabs Emirates[44] and Malaysia[53] among a similar group of cement factory workers. The higher prevalence observed may have been due to other possible respiratory infections such as tuberculosis which may not have been appropriately diagnosed in time past. Also, selection criteria were based on self reporting and diagnosis was not confirmed by laboratory investigations. In the index study, cement dust exposed workers were nearly three times more likely to report cough than unexposed workers. Adequate use of PPE at the individual level and efficiency of dust control measures may reduce the risk of acquiring cough and other respiratory symptoms.

Chest pain was the second most commonly occurring symptom in this study with a higher prevalence in the exposed than in the unexposed group. This finding is comparable to a study done among cement workers in Rivers State where chest pain was the most frequently occurring symptom.[32] Generally, chest pain has not been commonly reported among cement workers as compared to workers in other dust related industry.[10,44,45,54,55] In a study done among quarry workers, chest pain was the most frequent symptom reported and sputum production was the least.

Studies have consistently shown an increase in respiratory symptoms among dust exposed workers than in the unexposed groups.[10, 32, 54] Inhalation of cement dust may cause inflammation, airway obstruction and hyperplasia of mucus secreting glands. This results in physiologic response manifesting as cough and other respiratory symptoms. The differences in respiratory symptoms observed among the exposed and unexposed group were statistically significant. It can therefore be concluded that higher respiratory symptoms found in this study was most likely due to prolonged inhalation of cement dust. It is important to reduce to as low as possible the risk of acquiring respiratory diseases among cement factory workers because of the multiple adverse effects that may arise. These symptoms may not only cause discomfort among workers, they can also interfere with job processes causing an increase in work place accidents. This may increase sickness absence among workers and consequently exerting a negative impact on productivity. In addition, respiratory symptoms may be the first pointer to chronic obstructive pulmonary disease and should be further investigated among workers. Adequate use of dust control measures may decrease the risk of acquiring respiratory diseases among workers in the cement factory.

Spirometry is a useful measure of lung function capacity that plays a vital role in early detection and prognosis of lung diseases.[43] However, age, gender and Body Mass Index have been shown to affect lung functions differently.[20] Lung function test results of operational and administrative workers were compared in this study. Generally, the workers in the operational section had lower lung function indices than workers in the administrative section. Age greater than 40 years has been reported as a risk factor for lung function impairment.[20] In this study, lung function indices were worse among workers in the operational group as compared to the administrative group, and this difference was statistically significant for mean FEV1% and PEFR. This result was comparable to a study done by Douglas in southern Nigeria which assessed peak expiratory flow rate and respiratory symptoms among cement factory workers where the PEFR showed marked reduction among cement dust exposed workers.[32] In another study done in Benin among cement factory workers, FEV1% and PEFR showed significantly lower values in cement dust exposed workers than in unexposed workers. The results of the index and above study however differed from a study carried out by Merenu among cement factory workers in Sokoto, Nigeria where PEFR results were similar between the exposed and unexposed groups.[20] All these studies used spirometry to assess lung functions and FEV1, FVC, FEV_FVC and PEFR and showed varying degrees of reduction among the exposed group than the unexposed. Among all the parameters assessed, FEV showed the most obvious changes in lung function capacity.

In addition, workers who had spent more than ten years in employment in the index study had more results of lung function impairment than workers that had spent less than ten years on the job. This finding is in keeping with a study done by Merenu among cement factory workers where lung function impairment occurred at mean employment duration of ten years. In the aforementioned studies, both groups were matched for age, sex and BMI.[20] This was different from studies done in Saudi Arabia and southern Nigeria, where deleterious effect of lung function occurred after a mean working duration of 5 and 4.4 years respectively.[31,32]

Cement dust particles have been shown to have inflammatory properties and it has been suggested that the observed changes in FEV may be due to reflex bronchospasm initiated by inhaled cement dust particles.[20] The aerodynamic diameter of cement particles range from 0.05 to 5.0 micrometers in diameter. These particles are respirable in size hence making cement dust an important cause of occupational respiratory diseases. Post mortem animal studies have shown tissue fibrosis and pockets of emphysema foci among animals exposed to cement dust. Also, findings from a study by Meo et al[11] suggests that cement dust may decrease lung and thoracic compliance by impairing intercoastal muscle performance. Frequent inhalation of cement dust may elicit an inflammatory response in the lungs that may result in anatomic or structural abnormalities. This may result in hyperinflation of mucus membrane, excess production of mucus and blockage of the airways causing obstructive lung disease. This may lead to bronchial asthma, bronchiectasis or COPD which may ultimately affect quality of life of the worker. Therefore, the differences in lung function parameters observed in this study are most likely due to cement dust inhalation. These time differences in lung function impairment may be due to poor utilization of control measures as was documented in the Merenu study.[20] Dose level of dust has been shown to have more deleterious effect on lung functions than duration of work. From the study done by Douglas, lung function impairment can occur with low duration of exposure when environmental dust levels exceed the threshold limit value.[32] Thus, periodic environmental monitoring of dust level is necessary to ensure dust level are within acceptable limits in order to prevent consequences from prolonged exposure to cement dust.

Chronic obstructive pulmonary disease (COPD) may arise as a consequence of prolonged deterioration in lung function capacity. The prevalence of COPD in this study was higher among the exposed operational workers than the unexposed administrative workers. The prevalence rate of COPD in this study is comparable to a study among cement truck loaders in Jos, Nigeria.[45] The study group comprised of workers with high exposure to cement dust while the control group comprised of unexposed workers from a tertiary institution. The findings of the aforementioned studies were slightly higher than a study done in Tanzania among cement factory workers where the prevalence of COPD was higher among the exposed than unexposed group.[54] However, the difference in prevalence may be due to diagnostic criteria for COPD that was used. In this study the Burden Of Chronic Lung Disease Initiative (BOLD) diagnostic criteria was used which includes workers presenting with only symptoms of respiratory disease. In the BOLD study, stage one disease was excluded which suggests that the prevalence of COPD may have been higher than reported.[41]

Also, the prevalence of COPD in the index study is much higher than the prevalence of COPD among urban residents in Ife and Lagos cities of South Western Nigeria.[50-51] This marked variation of prevalence from the index study may have been due to differences in selection of target population. The target population of the latter study was drawn from the general population with respondents having varying degrees of risk factor for COPD. In this study, the respondents were drawn from workers in a cement factory and mounting evidence suggests that occupational exposures play a prominent role in the development of COPD. Also, the American Thoracic Society (ATS), a reputable body concerned with issues of respiratory medicine has consistently advocated for high prioritization of occupational exposures in the prevention of COPD.[23,28]

The prevalence of COPD in the operational group was higher than that of the administrative group and the difference was statistically significant. The synergistic effect of other risk factors may have been responsible for the occurrence of COPD observed in the administrative group. Among the risk factors of COPD, use of biomass fuel was a strong predictor of COPD among workers in the operational group. The prevalence of COPD was higher among workers that use biomass fuel as the principal source of fuel than workers that use other methods of cooking and this difference was statistically significant. This finding is in keeping with a study carried out among urban women in South West Nigeria where the COPD prevalence was five times higher among women who cook with firewood than women who use other cooking methods.[55] Even though this study was carried out among women, the risk of acquiring COPD from use of biomass fuel in men cannot be ruled out. This is because these men reside in the same house with the women and the dust accrued from cooking may linger in the environment for a period of time, thus exposing other household members to a similar risk of exposure. This explanation was reinforced by a study conducted among male and female urban residents in Lagos Nigeria, where the prevalence of COPD was found to be higher among men than women.[51] In addition, when findings of the study were stratified by risk factors, occupational exposure to dust and domestic exposure to biomass fuel were the strongest predictors of COPD in comparison to other risk factors.[51]

The role of Body Mass Index (BMI) as a risk factor for developing COPD was assessed. The BMI of the operational group was comparable to that of the administrative group with obese workers constituting a greater proportion in both groups. The prevalence of COPD had the highest frequency among obese workers in the operational group as compared to obese workers in the administrative group. However, this difference was not statistically significant. Also, gender among the administrative group was a predictor of acquiring COPD. Being a male was nearly three times associated with the risk was than being female.

Workers in the operational section had a higher risk of developing COPD than workers in the administrative section. The variation in the prevalence of COPD recorded among workers in the operational and administrative group in the above studies may be due to the distinct level of dust pollution among the various work sites. In addition, the differences observed across factories may be due to discrepancies in the effectiveness of control measures instituted. Therefore, multiple control measures should be instituted in factories to reduce consequences of exposure to hazards.

Among workers in the operational group, the main predictors identified were being above forty years of age and cooking with coal biomass fuel. Workers above forty years of age were three times more likely to develop COPD than workers below forty years of age. Also, workers that cook with biomass fuel were nearly three times at risk of developing COPD than workers who cook with other sources of fuel. This implies that workers exposed to cement dust who also cook with firewood have an additional risk of developing COPD than workers who do not. Follow up studies are recommended to calculate excess risk and population attributable risk of COPD ascribed to cement dust.

Respiratory symptoms with declining lung function values were frequently observed among workers exposed to a higher concentration of dust than workers exposed to lower levels of dust. In this study, the highest concentration of dust was found in the packing area. Other work sites in the production and manufacturing area also had high dust levels. The dust in the administrative and maintenance areas recorded the lowest values and this difference was statistically significant (f = 2.508, p= 0.032). Majority of the dust concentrations in the work sites were within the allowed limits of 10mg/m3 set by the International Control of Substance Hazardous to Health Regulation. However, the dust in the packing and production area clearly exceeds this reference value. This finding is comparable to studies done in Tanzania, Ethiopia and UAE, where dust levels were highest in the packing and crushing section.[44,54] In all these studies, the lung function test results had poorer values among workers in the packing and crushing section. However, the values of dust concentration in the packing and crushing sections of the above mentioned studies were far higher than values obtained in this study. This difference may be due to varying degrees of implementation of control measures in the factories. In the index study, mechanical extraction of dust using dust control measure in addition to wet drilling were regularly done in the factory. However, despite the high level of safety measures practiced by the company in the index study, lung function was impaired in some workers as was shown by the test results. This may raise concerns over what is considered the allowable limit for dust exposure in our environment. It may be that lung function impairment can occur at lower levels in this region probably from synergistic effect from exposures to other poorly regulated environmental hazards. Similar findings have been documented in a study in Netherlands where workers in a cement factory had impaired lung function despite the fact that dust levels were within the allowed limits.[57] Therefore, periodic evaluation of reference limits for hazardous substances is recommended because exposure status may change over time. Another explanation for this finding may be due to time of intervention of proper control measures. It may be that prior to implementation of good intervention, lung function impairment may have occurred since changes may not be evident until decades later. Also, differences in manifestation of consequences of hazards vary among individuals due to genetic differences.

In addition, there was a strong negative linear relationship between exposure to dust and lung function tests. As dust level increased across the groups, FEV and PEFR decreased across the groups as well. This result was statistically significant. Linear regression further showed that for every unit change in dust level, FEV decreased by 0.223L. This may imply that continous exposure to high dust levels may have a deleterious effect on lung function which may become irreversible over time, leading to COPD or other chronic diseases. Regular environmental monitoring should be carried out to ensure dust levels are within allowed limits. Also, regular maintenance of dust extraction machines should be carried out to prevent excessive release of dust from these machines.

Occupational Safety and Health Administration (OSHA) recommends that personal protective equipment (PPE) should augment other engineering and administrative control efforts in reducing work place hazards. Generally, the use of personal protective devices among workers in the factory was high among workers in the operational group. Majority of workers used at least one form of PPE always. This was comparable to a study done among quarry workers in South East Nigeria, where majority of workers were reported to use PPE. However, this finding was a complete contrast from a study carried out among cement factory workers in Ethiopia,[18] where none of the workers were found wearing PPE. In the study, only about a quarter of workers in the crushing section were seen covering their face with a piece of cloth to prevent inhalation of cement dust. Similarly, in another study done by Omokhodion[55] in Nigeria among workers in a mill operator, majority of workers covered their mouth and nose with a piece of cloth, while less than a third of workers used respiratory protective devices. This very low utilization frequency of PPE found in these studies may be due to deficient occupational health policies and failure of employers to procure PPE for their workers. This explanation is in keeping with a report from Nigeria[54] that showed that many employers in developing countries rarely purchase PPE for their workers. In another study done by Isah and Okojie among welders in South-South Nigeria, the utilization of PPE was found to be low.[58] This finding was reiterated in another study by Sabitu among welders in Northern Nigeria,[59] where only about a third of employees used PPE.

The reason for the low utilization frequency of PPE found in the aforementioned studies may be as a result of poor knowledge of job hazards and safety practices. A review of occupational health records from 2000 to 2013 by Aguwa showed that utilization of PPE was grossly deficient in many occupational health settings across the globe.[93]The findings were consistent in the production, agriculture, health, construction and other sectors evaluated. Most of the workers were negatively disposed to using PPE for a wide range of reasons. Poor knowledge of hazards was reported consistently across countries and occupational groups.

In this study, good knowledge of hazards was observed among majority of workers in the operational and administrative group. This finding is comparable to a study done in Ghana among workers in a cement factory to assess occupational history and safety devices where workers were shown to have high, knowledge of hazards and safety devices.[61] In another study, among cement factory workers in UAE,[60] the level of knowledge of job hazards and safety devices though high, were slightly lower than levels recorded in this study.

However, the findings in the index and aforementioned studies were different from a study carried out among artisans which included: welders, mechanics, carpenters, quarry and cement workers.[15] The workers had a grossly deficient level of knowledge concerning PPE use and job hazards. Consequently, utilization of PPE among these workers was abysmally low. In the study done in UAE, workers had good knowledge of hazards, however less than ten percent of the workers were trained on PPE use and this may explain the very low utilization frequency of safety devices found in the study.[95] However, just as Thomas Legge noted decades ago, workers should not be left to find out of the dangers of the work they do because sometimes, it may be at a dear cost, involving loss of lives.[34] Therefore, training of workers on job hazards and use of safety devices should be an integral component of every occupational health practice. Studies have shown that even when workers have high level of knowledge, utilization of PPE may still be poor as was found in the study done among welders by Isah and Okojie in Benin and Sabitu in Zaria, Nigeria.[58-59] This suggests that knowledge of hazards and safety devices alone may not translate to practice as other factors may interact to influence PPE use among workers.

Avoidance of consequence of hazard and availability of PPE were the least reported motivating factor for PPE use reported among the administrative and operational group in this study. This finding is comparable to a study done by Merenu and al-Naemi in Nigeria and UAE among cement factory workers which showed that even though PPE was provided on-site by employers, compliance to PPE was still poor.[20] This suggests that mere provision of safety devices may not be sufficient motivation for PPE use among workers. The predominant motivators for utilization of safety devices in the operational group was previous experience with hazard while that of the administrative group was avoidance of consequence of hazard (knowledge of hazard) and enforcement by management. This is in keeping with Thomas Legge"s aphorism which highlighted the importance of bringing an external influence to bear in the control of hazards.[34] Factors external to the worker such as supervision will go a long way in controlling work place hazards. However, most companies don't enforce safety measures, leaving many workers unsupervised and this situation may even be worse in the informal occupational sectors where little or no supervision is done.[15,58,59] This finding may explain the poor utilization of protective devices reported by many studies.

Factors responsible for non-compliance to PPE use reported in this study were inclusive of discomfort, interference with work and inconvenience. Majority of workers reported discomfort as a major hindrance to PPE use. This finding was similar to that of the occupational review by Aguwa.[62] In the study, interference with breathing was the most common reason given by dust exposed workers for not using respirators. The degree of discomfort experienced may be due to the type of safety device used. Face mask was reported as the least type of respiratory device used in this study and this was in agreement with findings from a study among cement factory workers in Ghana and another study conducted among quarry workers in Nigeria. The low utilization of safety devices in both studies may have been due to discomfort as reported by respondents in the index study and the study by Aguwa.[62] This discomfort may be as a result of disparity in size of available PPE and anthropometry of the individuals concerned or disparity in temperature zones between manufacturing sites and user country. Discomfort affecting the respiratory system may be less tolerable than that of other body parts consequently leading to low levels of compliance among workers. Majority of workers in this study were overweight and it is likely that PPE procured by employees did not fit adequately.

Conclusion: Cement factory workers are exposed to cement dust at various manufacturing and production points and prolonged inhalation of toxic levels of cement dust can provoke clinical and inflammatory response that may result in functional and structural abnormalities. It can therefore be concluded that that impaired lung functions found in this study may have been due to exposure to high levels of cement dust for prolonged periods in addition to use of poorly fitted PPE among factory workers.

Recommendations: Employers should ensure that procured safety devices are suited to each individual's anthropometry to ensure the worker is truly protected from dust and other hazards. Also, adequate occupational health records should be kept by health workers in factories to enable an objective assessment of occupational health problems. Health education should be conducted periodically for workers to reduce risk of exposure to hazard. **REFERENCES**

1. United Nations. UN general assembly political declaration of NCDs: Non–communicable Diseases and occupational health. Accessed online at www.un.org/ga/search/view/ symbol=A/66/L.1 on Jan 2, 2013

2. International Labour Organization. The prevention of occupational diseases. *Technical report for world health and safety day*, Geneva; 2013

3. World Health Organization (WHO). Occupational and work – related diseases. 2014. Accessed online at www.who.int/occupational_health/activities/occupational_work_diseases/en/ on October 10, 2013

4. International Labour Organization (ILO). List of occupational diseases. *Technical report for Occupational safety and Health series (74)*, Geneva; 2010

5. Kwesi A, Kwasi D. Occupational health and safety, key issues and concerns in Ghana. *International Journal of Business and Social Science*.2003; 2 (14), 119-24

6. Ekpenyong C, Ettebong E, Akpan E. Urban city transportation mode and respiratory health effect of air pollution: a cross-sectional study among transit and non-transit workers in Nigeria. *BMJ* 2012;2:1-13.

7. Akanbi MO, Ukoli CO, Erhabor GE, Akanbi FO, Gordon SB. The burden of respiratory disease in Nigeria. *Afr J Respir Med*. 2009;1:10-16

8. Concha-Barrientos M SK, Plunnet L .The contribution of occupational risks to global burden of diseases: Summary and nextsteps.

Medlav. 2006;97(2):313–21.

9. Asogwa SE. *A guide to occupational health practice in developing countries, 3rd edition*, Snaap Press Ltd, Enugu. 2008; 1-37

10. Shaikh S, Nafees AA, Khetpal V, Jamali AA, MA A, A Y. Respiratory symptoms and illnesses among brick kiln workers: a cross sectional study from rural districts of Pakistan. *BMC Public Health*. 2012;12:999-1005

Meo SA. Lung function in Pakistani workers. *Int J Environ Health Res*. 2006;16:193 -203.