Respiratory Health Effects of Occupational Exposure to Flour Dust among Flour Mill Workers in Edo and Delta States

Ibekwe[1]

Abstract

Introduction: The study was carried out to assess the level of suspended particulate matter (dust) in the work environment of flour mills in Edo and Delta States and to ascertain the respiratory health effect of occupational exposure to flour dust by comparing the prevalence of respiratory symptoms amongst these flour mill workers to that of an unexposed group.

Methods: Comparative cross-sectional study designed was utilized for the study and it was carried out over a period of six months, (Nov 2010 to May 2011) among 200 flour mill workers and 200 hospital workers in Edo and Delta states. A modified Medical Research Council (MRC) questionnaire which was interviewer administered and Haz dust particulate monitor was used to collect data. Data analysis was carried out using SPSS version 17.

Results: The level of (dust) suspended particulate matter in the work environment of the flour mills was 1.08mg/m3, whereas in the control site it was 0.03mg/m3,this was statistically significant ($p < 0.015$). Also the prevalence of all the symptoms was higher among the flour mill workers compared with that of an unexposed group, and this was statistically significant for most of the symptoms ($p < 0.001$).

Conclusion: The level of suspended particulate matter in the work environment of the flour mills exceeded the set limits by the regulatory body in the country, hence the need for the management of the flour mills to put in place better dust control measures as well as carry out regular medical checks to assess the health of the workers.

Key words: *Respiratory Symptoms; Flour Mill Workers; Edo and Delta States*

Correspondence: *Dr Ibekwe*

Introduction

Flour dust is hazardous to health; it is an asthmagen, known to cause sensitization, allergic rhinitis and occupational asthma among bakers and millers.[1,2]When inhaled grain dust can affect the respiratory tract in a variety of ways, it can cause a wide range of acute and chronic respiratory illnesses including allergic rhinitis, bronchial asthma, bronchitis, bronchiolitis, emphysema etc. It can also affect other systems and organs in the body resulting in skin rashes, eye irritations, etc.[3,4] In the United Kingdom, flour and grain

dust are the second most commonly cited agent associated with occupational airway disease[5,6]

In the year 2000, Health safety and Executives (HSE) estimated that between 1,500 and 3,000 persons developed occupational respiratory disorders from grain/flour dust annually, rising to 7,000 cases per year if respiratory disorders made worse by work is included.[5,7] The cost of occupational airway disease resulting from grain/flour dust is estimated to be £ 1.1 billion over ten years, i.e N27.5 billion in a year. The cost can be significant for the sufferer; there is ill health, as well as change or loss of employment. Employers loose valued workers and face the prospects of litigation, while the society bears the cost of social security benefits and loss revenue from income tax.[8,9] With increasing industrialization and urbanization in developing countries, there has been an attendant proliferation of fast food and bakery industries nationwide. Meanwhile very few studies have been carried out to investigate the respiratory health of workers in grain/flour producing and flour using sectors in Nigeria. The study was therefore carried out to determine the level of suspended particulate matter (dust) in the work environment of flour mills in Edo and Delta States and to ascertain the respiratory health effects of occupational exposure by comparing the prevalence of respiratory symptoms amongst these flour mill workers to that of an unexposed group.

Materials & Methods

The study was carried out in two agro-industrial complexes located in Edo and Delta states. Both are located in the tropical rain forest belt. A comparative cross-sectional study design was utilized for the study which was conducted over a period of six months (Nov 2010 to May 2011). A sample size of 125 was estimated using formular for comparative study,[11] however there were a total of 200 flour dust exposed workers in both flour mill and all were selected for the study. Simple random sampling technique was used to select 200 junior staff of the University of Benin teaching hospital. The exposed were flour dust exposed workers who had been in continuous employment in both flour mills for at least one year preceding the study. The controls were the unexposed hospital workers who are of the same socio-economic class as the flour dust exposed workers. The exposed and the controls were matched for age (within a 10-year range), sex and height (within 10cm range) on a group frequency-matching techniques to ensure that they were comparable and thus to avoid the confounding effects of age, sex and height in lung function measurements.[12] All flourmill workers in both companies who had been in continuous employment in the grain/flour industry for at least one year preceding the study were included for the study as well as all junior staff of UBTH who had been in continuous employment for at least one year preceding the study. The participants in the unexposed group were selected using simple random sampling technique from a list of junior staff in the technical department of UBTH. Data was collected using Modified Medical Research Council questionnaire and hand held spirometer.[13] The questionnaire was pre-tested at Juno foods a cereal manufacturing company. Data was also collected using Haz dust particulate monitor, model number HD-

1000. Sampling was carried out in 5 selected locations in each of the industries and these were areas of high level of dust concentration in the industries. Data analysis was carried out with SPSS version 17.0, and the data was presented in percentages, proportion and tables. Where it was applicable analysis was carried out with chi-square test, t-test, z-test and anova. The level of significance was set at $p < 0.05$. Ethical clearance was obtained from the ethics and research Committee of University of Benin Teaching Hospital, Benin before the commencement of the study. Permission to conduct the study was obtained from the management of the various flour mills. Written informed consent was also obtained from the participants after full explanation that their confidentiality was assured.

Results

Flour dust exposed workers in both flour mills were 200 and all were selected for the study. A control group made up of 200 junior staff of the University of Benin Teaching Hospital, matched for age, sex and height with the flour mill workers also participated in the study. All the flour mill respondents were males; as a result only male controls were recruited for the survey. The mean age ± SD of flour mill respondents was 39.8 ±10.05 years, while that of the unexposed group was 39.9 ±9.94 years.

Table 1: Respondent's demographic characteristics

Socio-demographic Variable	Flour mill workers N = 200 n (%)	Unexposed group N = 200 n(%)	Total N N = 400		P value
Age (year)					
15 – 24	14 (7.0)	11 (5.5)	25 (6.2)		
25 – 34	46 (23.0)	49 (24.5)	95 (23.8)		
35 – 44	70 (35.0)	69 (34.5)	39 (34.8)	$\beta^3 = 0.502$	0.973
45 – 54	58 (29.0)	58 (29.0)	116 (29.0)		
55 – 64	12 (6.0)	13 (6.5)	25 (6.2)		
Mean age ±S.D	39.8 ±10.05	39.9 ± 9.94	39.9 ± 9.99	**t-test** = - 0.140	0.889
Height (cm)					
Mean ±S.D	172 .79 ±7.54	172.90 ±7.24	172.84 ±7.38	**t- test** = -0.142	0.887
Education					
None	3 (1.5)	0 (0.0)	3 (0.8)		
Primary	58 (29.0)	57 (28.5)	115 (28.7)	$x^2 = 28.001$**	<0.001*
Secondary	121 (60.5)	137 (68.5)	258 (64.5)		
Tertiary	18 (9.0)	6 (3.0)	24 (6.0)		
Marital Status					
Single	44 (22.0)	37 (18.5)	81 (20.2)	$\beta^3 = 0.706$**	0.684
Married	155 (77.5)	162 (81.0)	317 (79.3)		
Divorced	1 (0.5)	1 (0.5)	2 (0.5)		
Duration of employment (year)					
< 5	57 (28.5)	74 (37.0)	131 (32.8)		
≥ 5-10	54 (27.0)	52 (26.0)	106 (26.5)	β^3 **test** = 3.624	0.163
> 10	89 (44.5)	74 (37.0)	163 (40.8)		
Mean ± S.D	10.00±2.0	10.00 ±3.0	10.00 ±2.0	**t-test** = 0.794	0.427

❖ * *Significant at p < 0.05* ** *fisher's exact*

Table 2: Assessment of Particulate Concentrations in air at flour mill and control site

Parameter	Flour mill Site	Control Site	t-test	P value	National ambient air quality std.
Total suspended particulate (mg/m^3)					
Mean ± SEM	1.08±0.9	0.03±0.007	1.852	0.015*	0.250
Range	0.23-3.05	0.00-0.05			

**Significant at $p < 0.05$*

Table 3: Prevalence of Respiratory Symptoms among exposed and unexposed respondents

Respiratory Symptoms	Flour mill workers (n = 200) n (%)	Unexposed group (n = 200) n (%)	Total N (N = 400) n (%)	β^3 test	P value	Prevalence rates (PR)	95% C.I.
Cough	100 (50.0)	23 (11.5)	123 (30.8)	69.608	<0.001*	7.696	4.597 – 12.884
Sputum production	56 (28.0)	10 (5.0)	66 (16.5)	38.396	<0.001*	7.389	3.644 – 14.982
Wheeze	25 (12.5)	17 (8.5)	42 (10.5)	1.703	0.192	1.538	0.803 – 2.946
Breathlessness	33 (16.5)	5 (2.5)	38 (9.5)	22.797	<0.001*	7.707	2.942 – 20.188
Nasal discharge	35 (17.5)	26 (13.0)	61 (15.2)	1.567	0.211	1.420	0.819 – 2.461

** Significant at $P < 0.05$* *Multiple responses*

Seventy (35.0%) of the flour mill respondents and 69 (34.5%) of the Unexposed respondents were in the 35 – 44 year age group respectively. There were more single respondents among the flour mill workers 44 (22.0%) than in the unexposed group 37 (18.5%), but in the two groups majority of the respondents were married. This difference was not statistically significant. One hundred and twenty one (60.5%) of the flour mill workers and 137 (68.5%) of the unexposed respondents have completed their secondary education, but

Table 4: Prevalence of Respiratory symptoms among Non-smoking respondents

	Non Smokers				
Respiratory Symptoms	Flour mill workers (n = 155)	Unexposed group (n= 130)	Total (n=285)	Test statistics (β^{3l}test)	P value
Cough	80(51.6)	17 (17.3)	97(34.0)	46.765	<0.001*
Sputum production	43(27.7)	8 (6.2)	51(17.1)	22.427	<0.001*
Wheeze	19 (12.3)	12(9.2)	31(10.9)	0.668	0.450
Breathlessness	23 (14.8)	3(2.3)	26(9.1)	13.391**	<0.001*
Nasal discharge	28(18.1)	17(13.1)	45(15.8)	1.323	0.260

*significant at $p < 0.05$ ** Fisher's exact

with respect to tertiary education a greater proportion 18(9.0%) of the flour mill respondents have completed theirs' compared with 6(3.0) %) from the unexposed group. This difference was significant across the groups. With respect to duration of employment, 89 (44.5%) of the flour mill workers had spent greater than 10 years in employment compared to 77 (37.0%) among the unexposed group. This difference was not significant across the groups. (Table 1)

Table 2 shows the particulate concentration in air at the flour mills and control site. The mean total suspended particulate concentration in the flour mill site is 1.08mg/m^3, this concentration is significantly ($p < 0.015$) higher in the flour mills than in the control site.

The prevalence of all the respiratory symptoms was higher among the flour mill workers compared to the unexposed group, and this was statistically significant ($p < 0.001$) for most of the symptoms. The most prevalent symptom among the flour mill group was cough (50.0%), and the odds of flour mill workers experiencing most of the symptoms were at least 7 times higher compared to the unexposed group. (Table 3)

Among the non-smoking respondents the prevalence of all the respiratory symptoms was also higher among the flour mill workers compared to the unexposed population. This was statistically significant ($p < 0.001$) for most of the symptoms. (Table 4)

Most of the respondents 196 (98.0%) were aware of the kind of PPE's used in their workplace, and these PPE's includes, industrial nose mask, paper nose mask, respirator, safety boots, cover all, eye goggles, e. t. c . (Figure 1)

Figure 2 describes the pattern of use of PPE by the respondents. A greater proportion of the respondents 123(61.5%) claimed they always put on their personal protective equipment while working, whereas 33(16.5%) claimed

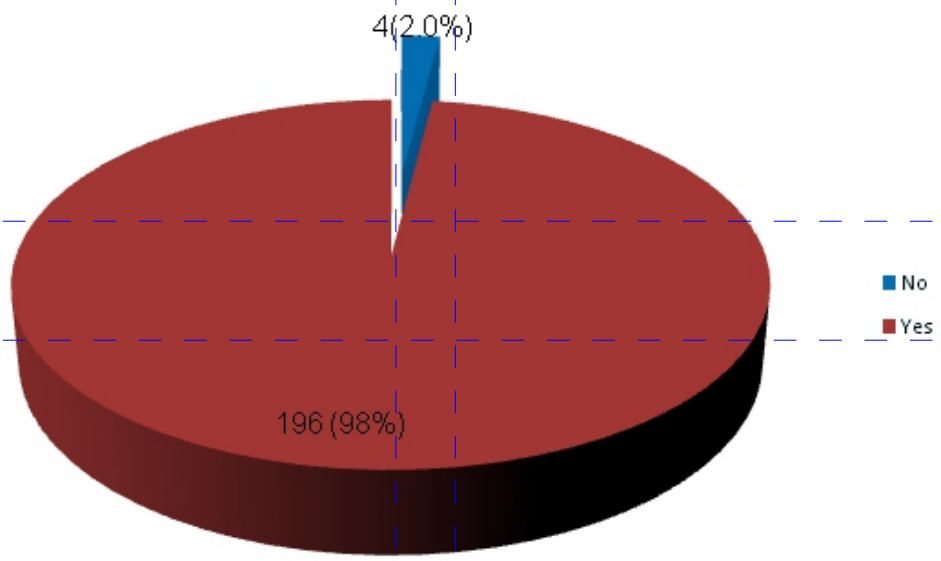

Figure 1: *Awareness of Personal Protective Equipment*

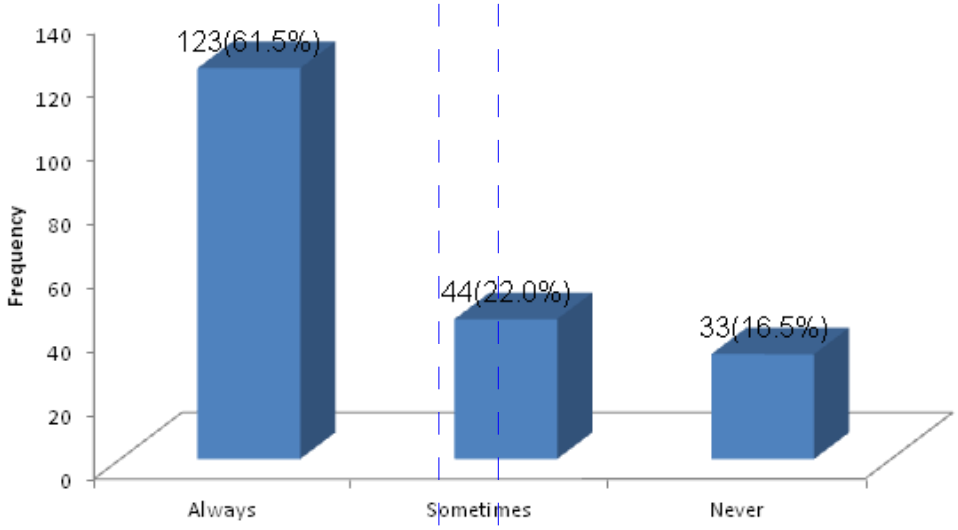

Figure 2: *Pattern of Use of PPE by the Respondents*

they never used it even when it was available, others 44 (22.0%) claimed they used their PPE's sometimes especially when the supervisor was present.

Discussion

As wheat grain is processed into flour, fine particles of dust become airborne, and as the worker breaths in air, these fine dust particles

are trapped in the airways and cause various health hazards for the worker. Various measures should be put in place by the management of these flour mills in order to limit the adverse health effect of flour dust on the workers. In this study the level or suspended particles (dust) in the environment of the flour mills was measured using Haz dust particulate monitor. The mean total suspended particulates (dust) in the work environment of the flour mills was 1.08mg/ m^3 and this was higher than the limit set by the regulatory body in Nigeria, i.e the Federal Ministry of Environment (FMENV). This body has set the limit of 0.25 mg/ m^3 for TSP. This findings is similar to that found in other parts of the world [13,16,17,18], as well as that seen in an earlier study in Ibadan, South Western Nigeria among wheat flour mill workers where the mean TSP in air at their production sites was 3.6 mg/ [(3)11]far above the limit in the country. It is surprising that an earlier study in Ibadan South Western Nigeria, had limits of TSP higher than the level permitted in the country, as well as this present study yet the regulatory body has not brought any of the offending industries to face the law and get punished for not complying to set rules. It is therefore pertinent that the Federal Government of Nigeria should empower these agencies of the government adequately to persecute offenders. It is quite commendable that the level of awareness on personal protective equipment was high (98.0 %) which means that most of the flour mill respondents were aware of the devices that can be worn at work to prevent the adverse effect of dust at work place. The pattern of use of these PPE's shows that a little more than half of the respondents use these PPE's despite the high level of awareness. There is therefore need to adopt other behavior change communication strategies to translate this high level of awareness to utilization. The prevalence of respiratory symptoms was higher among the flour mill workers (exposed group) compared to the unexposed group. This finding however is not surprising as the difference in the prevalence of respiratory symptoms relates to the degree of dust pollution of the various work environments and the dust control mechanism/ measures available and utilized at the different work places. It is also important to note that increased respiratory symptoms among these workers connote signs of increased respiratory disorders, which implies that the job was already having a negative toll on their health. There is urgent need for the management of these flour mills to ensure that other first line measures such as engineering measures designed to control dust are present and functional while also applying other measures such as environment monitoring as this is a useful strategy for the control of the effects of dust on the health of the workers if it is adequately done at recommended intervals. It is also important that other adjunct measures such as wetting of floors are put in place especially at the elevator area where finished products (flour) are loaded into vehicles as well as at the storage area (silo) where raw grains are off loaded and stored. The need for continuous health education cannot be over emphasized as Sir Thomas Legge in his notable aphorism of occupational health says that “All workers should be told something of the danger of the material with which they come in contact, and not be left to find out for themselves – sometimes at the cost

of their lives."[19]Hence health education by way of seminars, workshops, health talks e.t.c. will go a long way in improving the attitude and behaviour of the workers towards health and safety measures in their workplace, which will ultimately reduce the amount of dust inhaled with its attendant respiratory symptoms and respiratory disorders. Smoking is one of the confounders of this study and stratification was carried out at the stage of analysis in order to control for this confounder. The result of the analysis has shown that among the non-smokers (having removed the effect of smoking), the respiratory symptoms were still higher among the flour mill workers compared to the non exposed respondents, hence grain/flour dust affect the respiratory health of the worker irrespective of the effect of cigarette smoke.

Conclusion/Recommendation

The level of suspended particulate matter in the flour mills was higher than the limit set by the regulatory body (FMENV) in the country. The prevalence of respiratory symptoms among the flour mill workers was also higher compared to that of an unexposed population. There is therefore need for the management of the flour mills to put in place better dust control measures, ensure that the exposure limit to grain/flour dust is not exceeded as well as carry out regular and periodic medical checks for the workers in order to detect on time those whose health are already being affected by the job.

References

1. Huy T, De Schipperk, Chan – Yeung M, Kennedy SM. Grain dust and lung Funtions; dose response relationship. *Am Rev. Respire Dis. 1991; 144: 1314 – 1321*
2. Chan-Yeung M, Enarson D, Grzbowski S. Grain dust and respiratory health. *Can. Med. Asso J. 1985; (10): 235-240*
3. Health and Safety Executive (HSE). Flour dust at work can cause asthma. Available from: http://www.hse.gov.uk/index.htm (accessed 30/08/2009)
4. Occupational Safety and Health Administration (OSHA). Dust and it's control. Available fromhttp://www.osha.gov/as/opa/foia/foia.htm (Accessed on 02/03/2009)
5. Elms J, Robimon E, Rahman S and Garrod A. Exposure to flour dust in UK bakeries|: current use of control measures. Annals of Occup.Hyg. 2005; 49 (1): 85 -91
6. Canadian encyclopedia. Flour milling. Available from http://corporate/Britannica.com/help/index.html. (Accessed on 20/02/2009
7. Pahwa P, McDuffie H and Dosman JA. Longitudinal changes in prevalence of respiratory Symptoms among Canadian grain elevator workers. *Chest 2006, Jun; 129(6): 1605 – 1613*
8. Cotton DJ, Graham BL, LI, KY, Froh F, Barnett GD and Dosman JA. Effects of grain dust exposure and smoking on respiratory symptoms and lung

functions. *J. Occup. Med. 1983; 25 (2): 131 – 141*

9. Bulat P, Myny K, Braeckman L, Van Sprundel M, Kusters E and DoekesG. Exposure to inhalable dust, wheat flour and alpha – amylase allergens in industrial and traditional bakeries. *Ann. Occup. Hyg. 2004, Jan; 48(1): 57- 63*
10. Medical Research Council (MRC) Committee on the Aetiology of Chronic Bronchitis. Standard questionnaire on respiratory symptoms. *Br. Med. J. 1960; 2(1): 1665-1668.*
11. IjadunolaKT, Erhabor GE, Onayade AA, Ijadunola MY, Fatuni AO and Asuzu MC. Prevalence of respiratory symptoms among wheat flour mill workers in Ibadan, Nigeria. *Am. J. of Ind. Med. 2004; 45: 251 -259*
12. Bonita R, Beaglehole R, Kjellstrom T. Basic epidemiology. 2nd ed. Geneva: WHO press; 2006. 80
13. Ige OM, Awoyemi OB. Respiratory Symptoms and Ventilatory function of bakery workers in Ibadan, Nigeria. *West Afr. J. Med. 2002; 21 (4): 316 – 318*
14. Tabona M, Chan- Young M, Enarson D, Maclean L, Dorken E. Host factors affecting longitudinal decline in spirometry among grain elevator workers. *Chest. 1984; 85 (6): 782 – 786*
15. Dimich - ward HD, Kennedy SM, Duttrick MA, Dybunico A and Chan-Yeung M. Evaluation of the respiratory health of dock workers who load grain cargoes in British Columbia. *Br. J. Ind. Med. 1995; 52: 273 – 278*
16. Mohammed H, Shamssain K. Respiratory Symptoms and pulmonary functions in flour processing workers in baking industry. *Am. J. of Ind. Med. 1995; 27 (3): 359 – 365*
17. Taylard A, TessierJF, Vergeret J, Pellet F, Faugere. JG.Gachie JP,Beziau F,Kombou L, Fontan J, Redon S, RiO P and Freour P. respiratory functions in flour mill workers *Eur. J. Epidem. 1988; 4(1):104-109*
18. Corey, P, Hutcheon M, Broder I and mintz S. Grain elevator workers show work related pulmonary function changes and dose-effect relationship with dust exposure. *Br. J. of ind. Med. 1982; 39:330-337*
19 Asogwa SE. Guide to occupational health practice in developing contries. 4th ed. Fourth dimension publishers: Benin; 2007.P.1-4