AMERICAN JOURNAL OF INDUSTRIAL MEDICINE 45:251–259 (2004)

Prevalence of Respiratory Symptoms Among Wheat Flour Mill Workers in Ibadan, Nigeria

K.T. Ijadunola, MBChB, FWACP,[1]* G.E. Erhabor, MBBS, FWACP,[2] A.A. Onayade, MBBS, MPH, FWACP,[1] M.Y. Ijadunola, MBChB,[3] A.O. Fatusi, MBChB, MPH, FWACP,[1] and M.C. Asuzu, MBBS, MSc, DOH, FMCPH[4]

Background *While investigations into occupational health problems of various groups of workers have been conducted in Nigeria, so far, very little attention has been paid to the health status of workers in the grain industry. The prevalence of respiratory symptoms among wheat flour mill workers and control groups in a medium size industrial setting in Nigeria was studied.*

Methods *The study employed a cross-sectional analytical design. Data were collected using structured interviews, work-site observations, and physical examination. Respondents consisted of 91 flour-millers, 30 matched internal controls from the maintenance unit of the same flour mill factory, and 121 matched external controls.*

Results *Fifty-four percent of the flour-millers reported at least one respiratory symptom compared with 30% of the internal controls ($P < 0.05$) and 19% of the external controls ($P < 0.001$). Most symptoms were significantly more prevalent among the flour-millers compared with control subjects, and this trend was more evident amongst non-smokers than ex-smokers.*

Conclusions *The study concluded that wheat flour mill workers in Nigeria, like grain workers elsewhere, were at an increased risk of developing both pulmonary and non-pulmonary symptoms compared with control subjects. The result has implications for improved dust control measures in the grain industry in Nigeria.* Am. J. Ind. Med. 45:251–259, 2004. © *2004 Wiley-Liss, Inc.*

KEY WORDS: respiratory symptoms; wheat flour mill workers; Nigeria

INTRODUCTION

Diseases of the upper respiratory tract are widespread in workers exposed to various dusts and closely correlate with the length of exposure [Pankova, 1992]. In developing countries, relatively large numbers of people are employed in industries processing agricultural products, and this has made the problem of exposure to vegetable dusts (grain, cotton, tobacco, tea) more serious there [WHO, 1993]. Cross-sectional epidemiological studies have shown a higher prevalence of respiratory symptoms among grain handlers compared with workers not so exposed, even after controlling for the effect of smoking [Bachmann and Myers, 1991; Laraqui et al., 2000; Smith et al., 2000; Viet et al., 2001]. Among related substances, wheat dust has been most frequently implicated as an allergen for allergic rhinitis and work related asthma in cereal flour workers [Prichard et al., 1994]. Non-specific respiratory irritation was considerably more common than sensitization as the cause of work-related symptoms in flour milling, baking, and other wheat flour based industries [Smith and Lumley, 1996]. However, while

[1]Department of Community Health, Obafemi Awolowo University, Ile-Ife, Nigeria
[2]Department of Medicine, Obafemi Awolowo University, Ile-Ife, Nigeria
[3]Unit of General Practice, State Hospital, Ile-Ife, Nigeria
[4]Department of Community Health, University of Ibadan, University College Hospital, Ibadan, Nigeria
Contract grant sponsor: Obafemi Awolowo University (OAU) Teaching Hospitals, Ile-Ife, Nigeria.
*Correspondence to: Dr. K.T. Ijadunola, Department of Community Health, College of Health Sciences, Obafemi Awolowo University, Ile-Ife, Nigeria.
E-mail: kijadun@yahoo.com, kijadun@oauife.edu.ng

Accepted 19 November 2003
DOI 10.1002/ajim.10344. Published online in Wiley InterScience (www.interscience.wiley.com)

few studies have compared workers exposed to different dust concentrations within the same workplace, external reference groups usually consisting of civic workers have most commonly been used for comparison. Since the intensity of exposure to flour dust may vary in different areas of the flour mill, job assignments in the factory may possibly determine the level of exposure, and thus the prevalence and severity of indices of respiratory disease.

While investigations into occupational health problems of various groups of workers have been conducted in Nigeria [Ogakwu, 1973; Sofoluwe, 1977; Jinadu, 1980; Oleru, 1980; Erhabor et al., 1992; Ige and Onadeko, 2000], very little attention has been paid to the health status of workers in the grain industry. With increasing industrialization and urbanization of our communities, there has been an attendant proliferation of fast food industries nationwide, creating an increased demand for wheat flour and its products. Consequently, there has been an attendant increase in the numbers of flour mill industries in the country, some of them employing as many as 500 workers [Jinadu and Malomo, 1986].

The present study was carried out to define the prevalence of respiratory symptoms among wheat flour mill workers and control groups in Ibadan, Nigeria. Dust concentrations in various sections of the flour mill were estimated in an attempt to relate clinical symptoms with particulate dust exposures. It is envisaged that the results of the study will provide baseline data towards making recommendations for environmental and personal dust control measures and subsequent evaluation of such intervention procedures in the grain industry in Nigeria.

SUBJECTS AND METHODS

Study Location

The study was carried out in the city of Ibadan, the capital of Oyo State, Southwest, Nigeria. The inhabitants are largely civil servants, traders, and factory workers.

Study Population/Design

The study employed a cross-sectional analytical design. The study population consisted of a study group and two control groups. The study group consisted of all 91 production workers of the largest flour mill factory in the city. These were all males who were directly engaged in flour milling, and were thus conceptually, a high-dust exposure group. The first group of controls consisted of all 30 male employees of the maintenance department of the flour mill factory, excluding five female caterers. These included automechanics, drivers, caterers, welders, electricians, and other artisans who had their tool shed situated opposite the mill plant, but were not directly engaged in flour milling. They were thus defined a low-dust exposure group and served as internal controls. None of them had ever been previously employed in a flour mill factory or related industry and they belonged to a similar socio-economic class as the study group. The other control group consisted of 121 civic male workers, out of the 145 employed in the maintenance section of the University of Ibadan, who had never been employed in a wheat flour mill or related industry. This group included ten females and they were excluded from the sample. The section consisted of a number of technical units including plumbing, electrical installations, transport, auto mechanic, civil maintenance, and phone exchange. These respondents also belonged to a similar socio-economic class as the study group and served as external controls. Respondents with previous history of chronic respiratory problems (such as treatment for bronchial asthma, chronic bronchitis/emphysema) prior to the commencement of their present employment were excluded from the study. No such categories were found among the production workers or the internal controls (probably as a result of the pre-employment and pre-placement screening policy of the flour mill factory), while five potential external controls were excluded based on this criterion. The study and control groups were further matched for age (within a 5-year range), sex, weight (within 2-kg range), and height (within 10-cm range) on a group basis using frequency-matching techniques [Abramson, 1990]. Ethical approval for the study was obtained from the ethical committee of the Obafemi Awolowo University (OAU) Teaching Hospitals, Ile-Ife, Nigeria.

Data Collection Techniques

A medical and occupational questionnaire was applied to assess the prevalence of symptoms among the respondents. This was based on a modified British Medical Research Council questionnaire on respiratory symptoms [Medical Research Council (MRC) Committee on the Aetiology of Chronic Bronchitis, 1960], as adapted by Femi-Pearse et al. [1973] in a previous study in Nigeria. Cough and sputum were said to be present when the subject had the symptoms either during the day or at night for 5 or more days each week; chronic bronchitis was defined as presence of sputum with or without cough on most days of the month for as long as 3 consecutive months of the year, for at least 2 consecutive years; breathlessness was defined as getting short of breath when walking with other people of same age on level ground or up a slight hill; chest tightness was defined as feeling tight in the chest/difficult breathing on the first days back at work on more than 50% of occasions and/or on other days too; wheeze was defined as ability of subject or others nearby to hear a whistling sound when subject was breathing; a non-smoker was one who had never smoked as much as one cigarette a day for as long as 1 year; an ex-smoker was one who smoked regularly as above, but has since stopped for at least 1 month preceding the survey. A current smoker was one

still smoking as defined even as of the time of the survey. Questions on other items such as rhinitis, conjunctivitis, dermatitis, smoking habits, and occupational history were included. The occupational part of the questionnaire addressed current job description, duration and location, and a detailed history of previous employment. Responses were validated by using factory records to cross-check variables such as age, job description, and years of employment. For the variables of job description and years of employment, there were no discrepancies between factory records and workers' self-report. Where there were age discrepancies between factory and self-report, ages reported by self were recorded. In addition, inspection of work-site environment was carried out with the help of a checklist adapted from the work of Phoon [1988] as guide. Physical examination of all subjects was carried out on site. This included measurement of height and weight. Measurement of standing height was done with a stadiometer (UNICEF/Raven Equipment Ltd.®) using standard procedure [Weiner and Lourie, 1969]. Body weight was taken with a portable weighing scale (UNICEF/Salter®) with light clothing and without shoes. Chest examination was carried out when indicated using standard medical examination procedures.

Dust sampling at the flour mill factory was carried out with technical assistance of the Pollution Prevention Laboratory, Department of Physics and the Department of Chemistry, both of the OAU, Ile-Ife, Nigeria. Samples of total suspended particulate (TSP) matter were collected on a 4-mm diameter membrane filter (Whatman Ltd., USA) with the use of a portable air sampler (model NR 344, Rotherve & Mitchel Ltd., England). Even though it was realized that this procedure could underestimate the personal dust exposure levels, it was done in place of personal sampling due to unavailability of equipment. Air was drawn through the sampler at the rate of 10 L/min (or a volumetric flow rate of 0.01 m^3/min), monitored via an accompanying flowmeter/calibrator. Air sampling was undertaken for periods ranging between 4 and 6 hrs/day on the various floors of the mill plant and the maintenance department and on several days while the study lasted. Dust concentration expressed in mg/m^3 was calculated from the changes in weight of the filter (before and after sampling) divided by the volume of air sampled. In all, about ten TSP samples were collected from each sampling location, and there were five such locations in the production unit and three in the maintenance department. In each case, the dust sampler was placed on raised platforms, but as close as possible to the vicinity and breathing zones of workers. The dust samples were further analyzed at the University Department of Food Science and Technology to confirm that they consisted of organic wheat flour material. The appearance of the stained granules of wheat were used to identify the particles under the microscope, and the shapes were compatible with that described for wheat by Schoch, and cited in Pomeranz and Meloan [1994].

Data Analysis

Data were analyzed by means of the Epi Info statistical package for personal computers (version 6.3), and "Computer Programs for Epidemiologists" (PEPI), version 3.0 [Gahlinger and Abramson, 1999]. Continuous variables that were normal in distribution (such as age and weight) were expressed as means (±standard deviation). In cases where the means were derived from a series of average measurements, as for dust levels, results were expressed as means (±standard error of the mean, SEM). Where continuous data were skewed, median values were stated as well. Statistical comparisons of the arithmetic means from the study and control groups were carried out using the student's *t*-test. Pair-wise comparison of means were done for the continuous variables of age, weight, height, and duration of current employment among the three occupational groups using the Games-Howell multiple comparison procedure of the *t*-test [Gahlinger and Abramson, 1999]. This procedure was undertaken because the Games-Howell test could accommodate three or more means simultaneously, and compare between groups (two at a time) as was needed in this study, and supply the results in a single file, as depicted in Table I below. Discrete data such as prevalence of symptoms among study and control groups were expressed as proportions (percentages). Statistical analysis of difference between proportions was done by the use of the χ^2-test. Whenever the expected cell frequencies were less than five, comparison of proportions was accomplished using the Fisher's exact test. Statistical significance was set at $P < 0.05$ for all values of the *t*-test and the χ^2-test.

RESULTS

Socio-Demographic Characteristics

Respondents were generally comparable in their socio-demographic characteristics (Table I). The production staff did not differ significantly from the external controls in age, height, weight, current and past smoking histories, and previous mining history. However, the internal controls were significantly older than the production staff ($P < 0.01$). Also the external controls had been employed on their current jobs for a significantly longer duration than both the production staff and the internal controls ($P < 0.01$). These factors were taken into consideration in Discussion.

Prevalence of Symptoms

Table II depicts the frequency of pulmonary and non-pulmonary symptoms among flour mill workers and control groups. The production staff had a significantly higher prevalence of several non-pulmonary symptoms compared with the external controls ($P < 0.001$). These symptoms included

TABLE I. Socio-Demographic Characteristics of Flour Mill Workers and Controls, Nigeria

	1	2	3	*P* values*		
Study factor	**Production staff (n = 91)**	**Internal controls (n = 30)**	**Outside controls (n = 121)**	**1 V 2**	**1 V 3**	**2 V 3**
Age (years)						
Mean ± SD	34.3 ± 8.8	38.9 ± 9.7	36.1 ± 9.6	<0.01	NS	NS
Height (cm)						
Mean ± SD	171.1 ± 12.5	171.1 ± 6.5	171.6 ± 5.6	NS	NS	NS
Weight (kg)						
Mean ± SD	63.0 ± 10.7	64.5 ± 8.1	64.2 ± 7.8	NS	NS	NS
Duration of current employment (years)						
Mean ± SD	5.6 ± 3.9	6.1 ± 4.0	11.7 ± 8.6	NS	<0.01	<0.01
Current smokers						
Number (%)	4 (4)	4 (13)	2 (2)	NS	NS	<0.05
Ex-smokers						
Number (%)	12 (13)	7 (23)	10 (8)	NS	NS	<0.05
Non-smokers						
Number (%)	75 (82)	19 (63)	109 (90)	NS	NS	<0.001
Previous mining history						
Number (%)	7 (8)	2 (7)	10 (8)	NS	NS	NS

*1 V 2 means 1 versus 2 etc.

eye irritation, eye discharge, conjunctivitis, nasal catarrh, and skin rash. When the production workers were compared with the internal controls at the flour mill, significant differences in prevalence of non-pulmonary symptoms existed for eye irritation ($P < 0.01$), nasal catarrh ($P < 0.05$), and skin rash ($P < 0.001$) only. The production staff reported higher frequencies of symptoms. The difference in prevalence of eye discharge and conjunctivitis between the two occupational groups, though higher among production workers than internal controls, was not statistically significant.

With regards to pulmonary symptoms, the prevalence among production workers (study group) was generally

TABLE II. Prevalence of Pulmonary and Non-Pulmonary Symptoms Among Flour Mill Workers and Controls, Nigeria

	1	2	3	*P* values		
Symptoms[a]	**Production staff (n = 91)**	**Internal controls (n = 30)**	**Outside controls (n = 121)**	**1 V 2**	**1 V 3**	**2 V 3**
Eye irritation	53 (58)	7 (23)	14 (12)	<0.01	<0.001	NS
Eye discharge	38 (42)	9 (30)	5 (4)	NS	<0.001	<0.001
Conjunctivitis	35 (39)	7 (23)	4 (3)	NS	<0.001	<0.001
Nasal catarrh	51 (56)	9 (30)	33 (27)	<0.05	<0.001	NS
Skin rash	38 (42)	1 (3)	2 (2)	<0.001	<0.001	NS
Cough	36 (40)	7 (23)	4 (3)	NS	<0.001	<0.01
Sputum production	51 (56)	6 (20)	6 (5)	<0.01	<0.001	<0.05
Chronic bronchitis	5 (6)	1 (3)	2 (2)	NS	NS	NS
Breathlessness	13 (14)	3 (10)	6 (5)	NS	<0.05	NS
Wheeze	6 (7)	3 (10)	1 (1)	NS	<0.05	NS
Shortness of breath with wheeze	6 (7)	2 (7)	1 (1)	NS	<0.05	NS
Chest pain	11 (12)	4 (13)	14 (11)	NS	NS	NS
Chest tightness	5 (6)	1 (3)	2 (2)	NS	NS	NS
Hemoptysis	2 (2)	0 (0)	2 (2)	NS	NS	NS

[a]Prevalence of symptoms were presented as frequencies and percentages in parentheses.

greater compared with external controls. However, statistical significance existed for cough and sputum production ($P < 0.001$), breathlessness, wheeze, and shortness of breath with wheeze ($P < 0.05$). Only sputum production was significantly more prevalent among the production staff compared with the internal controls ($P < 0.01$). The difference in prevalence of all other pulmonary symptoms between these groups was not statistically significant.

In all, 49 subjects (54%) among the production staff reported at least one respiratory symptom compared with nine subjects (30%) among the internal controls ($P < 0.05$), and 23 subjects (19%) among the external controls ($P < 0.001$, Fig. 1). The reported prevalence of pulmonary symptoms among the production staff were as follows: sputum production 56%, cough 40%, breathlessness 14%, chest pain 12%, wheeze 7%, shortness of breath with wheeze 7%, chronic bronchitis 6%, chest tightness 6%, and hemoptysis 2%.

Considering the prevalence of symptoms by smoking categories, among non-smokers (Table III), the production staff had a significantly higher prevalence of all non-pulmonary symptoms compared with the external controls ($P < 0.001$). However, only eye irritation and skin rash were significantly more prevalent among the production staff compared with the internal controls at the flour mill factory ($P < 0.05$ and $P < 0.01$, respectively). With regards to pulmonary symptoms, again, the production staff had the highest prevalence of all symptoms. Compared with the external controls, significant differences in prevalence existed for cough ($P < 0.001$), sputum production ($P < 0.001$), wheeze ($P < 0.05$), and shortness of breath with wheeze ($P < 0.05$). Furthermore, the production staff also reported a significantly higher prevalence of sputum production compared with the internal controls ($P < 0.01$). The prevalence of all other pulmonary symptoms did not differ significantly between the groups.

Among ex-smokers (Table IV), only eye discharge and skin rash were significantly more prevalent among the production staff compared with the external controls ($P < 0.05$). The prevalence of all other symptoms did not differ significantly among the three study groups. A further comparison of the prevalence of respiratory symptoms between non-smokers (Table III) and ex-smokers (Table IV) for all occupational groups (production staff, internal controls, and external controls) revealed no significant differences between the smoking categories. The proportions of respondents that were current smokers among the three study groups were so small that this precluded any meaningful comparisons between the groups.

Dust Sampling

The area sampling of dust concentration at the various sections of the flour mill factory is shown in Table V. The total sample particulate (TSP) of dust varied from 0.6 to 4.7 mg/m^3 on the shop floor (production unit) and 0.1 to 0.6 mg/m^3 at the maintenance workshop (work base of the internal controls). The TSP concentration at the various sites varied from day to day and at different times of the day, depending on the ambient climatic conditions. The dustiest section of the shop floor was the silo and the least dusty was the warehouse. On the average, the TSP concentration at the production unit was considerably higher compared with the maintenance unit ($P < 0.001$). Mean values at both sites, however, exceeded the Federal Environmental Protection Agency [Federal Environmental Protection Agency, 1991] standards of 0.25 mg/m^3 (250 μg/m^3), the ambient air limits for all

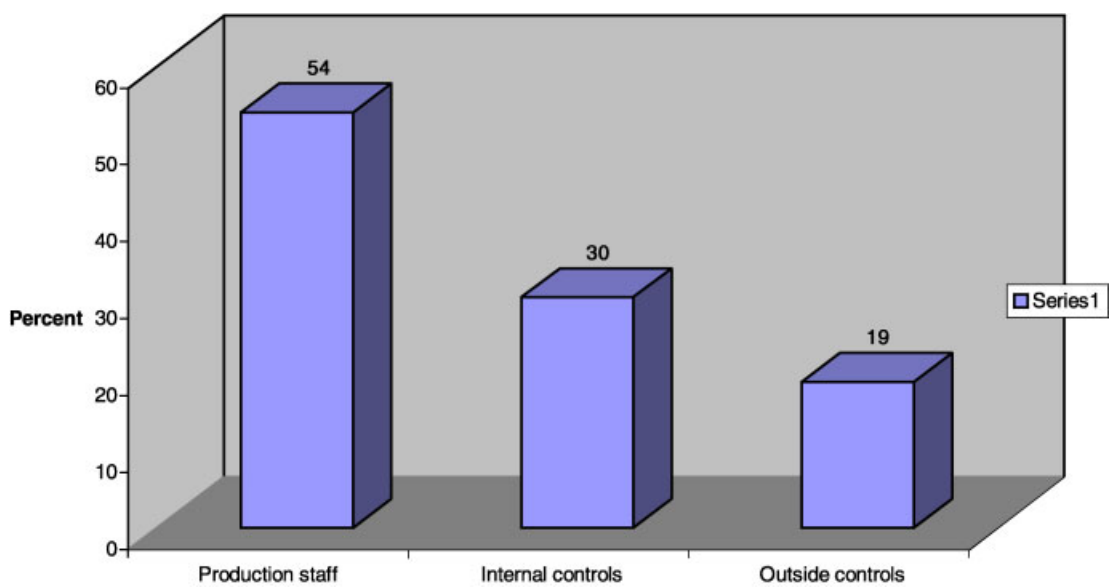

FIGURE 1. Proportion of production staff and controls reporting at least one respiratory symptom.

TABLE III. Prevalence of Pulmonary and Non-Pulmonary Symptoms Among Flour Mill Workers and Controls (Non-Smokers), Nigeria

	1	2	3	*P* values		
Symptoms[a]	Production staff (n = 91)	Internal controls (n = 30)	Outside controls (n = 121)	1 V 2	1 V 3	2 V 3
Eye irritation	44 (59)	5 (26)	8 (7)	<0.05	<0.001	<0.05
Eye discharge	30 (40)	6 (32)	4 (4)	NS	<0.001	<0.001
Conjunctivitis	29 (39)	5 (26)	3 (3)	NS	<0.001	<0.01
Nasal catarrh	42 (56)	6 (32)	26 (24)	NS	<0.001	NS
Skin rash	29 (39)	0 (0)	2 (2)	<0.01	<0.001	NS
Cough	30 (40)	4 (21)	4 (4)	NS	<0.001	<0.05
Sputum production	44 (59)	4 (21)	3 (3)	<0.01	<0.001	<0.01
Chronic bronchitis	5 (7)	1 (5)	2 (2)	NS	NS	NS
Breathlessness	9 (12)	2 (11)	6 (6)	NS	NS	NS
Wheeze	4 (5)	1 (5)	0 (0)	NS	<0.05	NS
Shortness of breath with wheeze	4 (5)	0 (0)	0 (0)	NS	<0.05	NS
Chest pain	9 (12)	2 (11)	12 (11)	NS	NS	NS
Chest tightness	4 (5)	0 (0)	1 (1)	NS	NS	NS
Hemoptysis	2 (3)	0 (0)	2 (2)	NS	NS	NS

[a]Prevalence of symptoms were presented as frequencies and percentages in parentheses.

particulate pollutants in Nigeria [Federal Environmental Protection Agency, 1991]. Despite this, however, none of either production workers or the internal controls wore any dust protective devices. The significantly higher TSP concentration on the shop floor compared with the maintenance workshop was congruent with the higher prevalence of pulmonary and non-pulmonary symptoms among production workers compared with the internal controls (Table II).

DISCUSSION

The study groups were suitably matched in terms of major demographic variables, smoking habits, and previous mining history, all of which could confound the prevalence of symptoms of respiratory disease. It was noted, however, that on the average, the internal control group was older than the study group, and that the external controls had been em-

TABLE IV. Prevalence of Pulmonary and Non-Pulmonary Symptoms Among Flour Mill Workers and Controls (Ex-Smokers), Nigeria

	1	2	3	*P* values		
Symptoms[a]	Production staff (n = 91)	Internal controls (n = 30)	Outside controls (n = 121)	1 V 2	1 V 3	2 V 3
Eye irritation	8 (67)	2 (29)	5 (50)	NS	NS	NS
Eye discharge	7 (58)	3 (43)	1 (10)	NS	<0.05	NS
Conjunctivitis	6 (50)	2 (29)	1 (10)	NS	NS	NS
Nasal catarrh	8 (67)	3 (43)	6 (60)	NS	NS	NS
Skin rash	7 (58)	1 (14)	0 (0)	NS	<0.05	NS
Cough	4 (33)	1 (14)	0 (0)	NS	NS	NS
Sputum production	5 (42)	2 (29)	2 (20)	NS	NS	NS
Chronic bronchitis	0 (0)	0 (0)	0 (0)	NS	NS	NS
Breathlessness	3 (25)	1 (14)	0 (0)	NS	NS	NS
Wheeze	2 (17)	2 (29)	1 (10)	NS	NS	NS
Shortness of breath with wheeze	2 (17)	2 (29)	1 (10)	NS	NS	NS
Chest pain	1 (8)	1 (14)	1 (10)	NS	NS	NS
Chest tightness	1 (8)	1 (14)	1 (10)	NS	NS	NS
Hemoptysis	0 (0)	0 (0)	0 (0)	NS	NS	NS

[a]Prevalence of symptoms were presented as frequencies and percentages in parentheses.

TABLE V. Assessment of Total Sample Particulate (TSP) of Dust at the Work Environment of Flour Mill Workers in Ibadan, Nigeria

	Sampling location		
	1	2	*P* value
Study factor	**Shop-floor (production unit)**	**Maintenance workshop**	**1 V 2**
TSP concentration			
Range (mg/m^3)	0.6–4.7	0.1–0.6	
Mean ± SEM (mg/m^3)	2.4 ± 2.0	0.4 ± 0.3	<0.001
Median (mg/m^3)	3.6	0.4	

ployed on their current jobs for a longer duration than both the study group and the internal controls. On the one hand, these findings could underestimate odds of developing respiratory disease in the study group compared with the control groups, by increasing the likelihood of respiratory disease in the control groups. On the other hand, however, other studies in the literature [doPico et al., 1977; Chan-Yeung et al., 1980; Broder et al., 1984] found no association between the prevalence of symptoms on the one hand, and either age, or duration of employment on the other.

The results of this study demonstrated that flour-millers in Ibadan were at an increased risk of developing both pulmonary and non-pulmonary disorders compared with control subjects. This is in agreement with reports from other investigators including doPico et al. [1977] and Cotton and Dosman [1978]. The findings also suggest a dose–response relationship between the degree of exposure to particulate dust and the prevalence of symptoms of respiratory disease in the occupational groups at the flour mill factory, as the production staff were not only found to work in a dustier environment, but also recorded a higher prevalence of respiratory disease compared with the internal controls. This is in keeping with the findings of Corey et al. [1982], and doPico et al. [1983]. However, while the threshold limit value (TLV) for nuisance particulates, a term usually applied to dusts thought to be inert, has been set at 0.25 mg/m^3 in Nigeria [Federal Environmental Protection Agency, 1991], several controlled epidemiological studies have demonstrated that wheat-flour/grain dust cannot be considered merely as a nuisance/inert dust. It has a range of biologic activities mediated through different cell types [Chan-Yeung et al., 1992]. Moreover, the results of area sampling of the flour mill factory in the present study revealed that the mean TSP concentrations at both the production unit and the maintenance section exceeded the TLV.

In this study, the prevalence of eye and nasal symptoms, and skin rash/irritation was significantly higher among the production staff compared with control subjects and this was more so for the external controls than the internal controls. Several other investigators including Tse et al. [1973], Chan-Yeung et al. [1980], doPico et al. [1983], Yach et al. [1985], Hogan et al. [1986], and Jinadu and Malomo [1986] have reported such increased prevalence of skin and mucous membrane symptoms among grain dust operatives. The prevalence figures recorded in this study were slightly higher than those reported by most of these other investigators. This, however, was not a surprising finding since the differences in the prevalence figures were likely to relate to the degree of dust pollution of the various work environments, and the dust control mechanisms available and utilized at the different workplaces. Unlike in many other locations, a majority of the production workers wore no personal dust protective devices, and were likely to partake in more manual operations than their counterparts elsewhere.

With regards to respiratory symptoms, 54% of the production staff reported at least one respiratory symptom. This was less than the 75% reported by Tse et al. [1973] among Canadian grain dust operatives but comparable with the 47% reported by Yach et al. [1985] among South African grain workers. Again, the production workers recorded significantly higher prevalence of respiratory symptoms compared with control groups and this was more evident among the non-smokers. This trend was similar to that reported by such investigators as Williams et al. [1964] and Becklake et al. [1977]. The harmful effects of smoking were once again demonstrated in this study. Among ex-smokers, for example, the prevalence of respiratory symptoms did not differ significantly between the occupational groups (as it did among non-smokers). Past history of smoking emerged as a strong factor among these ex-smokers in the production of chest symptoms (than exposure to particulate dust) by suggesting that there was no added risk of developing chest symptoms among production workers compared with control subjects. Although, it was noticeable that ex-smoking status probably acted as a positive effect modifier in the production of symptoms of breathlessness and wheeze among production workers, and as negative effect modifier for the symptoms of cough and sputum production among the same group, further analysis revealed no statistical significant differences in the prevalence of chest symptoms between non-smokers and

ex-smokers among the three occupational groups. Therefore, the only evidence of the effect of previous history of smoking was the comparison of the prevalence of chest symptoms across the occupational groups among ex-smokers separately, and among non-smokers separately as has been done in this study. It must be pointed out that the small proportions of ex-smokers in all the occupational groups might have led to an overall reduction of the risk of respiratory disease attributable to smoking among the occupational groups.

Unlike the studies of Broder et al. [1979], Chan-Yeung et al. [1980], and others that demonstrated a clear-cut gradient in the frequencies of some or all chest symptoms from non-smokers to ex-smokers and current smokers in all occupational groups compared, no such linear gradation was evident in this study. This again might not be unconnected with the small proportions of current and ex-smokers inherent in the study groups. We note, however, that the low occurrence of current or ex-smokers in this study was not likely due to the exclusion of participants who developed chronic respiratory disease prior to the commencement of their current employment from the study. On the one hand, the proportion of potential participants that were so excluded was quite small (nil for production workers and internal controls, 5[3%] for external controls) to have resulted in any significant effects. On the other hand, it was not participants who developed chronic respiratory disease that were excluded, but ''potential participants,'' who prior to the commencement of their present employment, had developed chronic respiratory disease. Had these individuals not been excluded, they would have accounted for a relative increase in the risk of respiratory disease among external controls (compared with production staff and internal controls) or a relative decrease in the risk of respiratory disease among production staff and internal controls when compared with external controls. A more probable explanation for the small proportion of current and ex-smokers is the generally low prevalence of smoking in Nigeria (variously quoted between 2 and 7% by Omokhodion and Sanya [2003] and Femi-Pearse et al. [1973]) probably resulting from socio-economic and related factors.

We noted that while the prevalence of cough and sputum production among the production staff was quite high, (40 and 56%, respectively), the more disabling conditions like breathlessness, wheeze, chest pain, hemoptysis, and chronic bronchitis was quite low and varied between 2 and 14%. This may, however, not be a surprising finding as the subjects in this study, as in most cross-sectional studies, might represent a ''survival population.'' Subjects who developed more disabling symptoms might have changed their jobs or left the establishment early. We did not consider the exclusion of subjects with history of chronic respiratory symptoms prior to their present jobs from the study an explanation for the low prevalence of more disabling conditions among the production workers, as no subject was so classified in this group, let alone being eventually excluded in the analysis. Curiously, none of the eight respondents in this study who presented with chronic bronchitis had a previous history of smoking, contrary to widely held views that this is mainly a disorder of smokers. Five of the subjects (63%) were production workers of the flour mill factory. This, again, was however, not a very surprising finding as other investigators such as Cohen and Osgood [1953] and Skoulas et al. [1964] have earlier documented that grain dust operatives could present with signs and symptoms of chronic obstructive pulmonary disease without previous history of smoking. Also Williams et al. [1964] and Tse et al. [1973] have posited that both cigarette smoking and exposure to grain dust might differentially result in chronic bronchitis.

CONCLUSIONS

Flour mill workers in Nigeria, like grain dust workers elsewhere, are at an increased risk of developing both pulmonary and skin/mucous membrane disorders compared with control subjects. Results of area sampling of dust also revealed that average measurements exceeded the TLV and yet, a majority of the workers wore no dust protective devices. These results have important implications for the grain industry in Nigeria, where there is insufficient legislation and workmen's compensation.

While evolution of mechanisms for lowering the dust concentration of worksites should continue to be a priority, grain workers should be educated continuously on the importance of wearing dust protective devices whenever they are provided to reduce their load of dust exposure. There is also need for more prospective research into the respiratory hazards of wheat/grain workers in Nigeria that would incorporate personal sampling of dust and spirometry. This would guide future attempts at setting standards for permissible dust exposure levels among wheat/grain workers bearing in mind that wheat/grain dust is not an inert dust.

ACKNOWLEDGMENTS

The invaluable contributions of the following members of staff of the OAU are hereby acknowledged: Prof. M.K. Jinadu of the Department of Nursing; Prof. Asubiojo and Dr. Oluyemi of the Department of Chemistry; Prof. A.F. Oluwole and Dr. Femi Ojo of the Pollution Research Laboratory, Department of Physics, Dr. Sumbo Abiose of the Department of Food Science and Technology.

REFERENCES

Abramson JH. 1990. Survey methods in community medicine. Edinburgh: Churchill and Livingstone.

Bachmann M, Myers JE. 1991. Grain dust and respiratory health in South African milling workers. Br J Ind Med 48:656–662.

Becklake MR, Jodoin G, Utz G, Lefort L, Rose B, Fraser RG. 1977. A health study of grain handlers in St. Lawrence river ports. Am Rev Respir Dis 115:200.

Broder I, Hutcheon MA, Mintz S, Corey P, Silverman F, Davies G, Leznoff A, Peress L, Thomas P. 1979. Comparison of respiratory variables in grain elevator workers and civil outside workers of Thunder Bay, Canada. Am Rev Resp Dis 119:193–203.

Broder I, Hutcheon MA, Mintz S, Davies G, Leznoff A, Thomas P, Corey P. 1984. Changes in respiratory variables of grain handlers and civil workers during their initial months of employment. Br J Ind Med 41:94–99.

Chan-Yeung M, Schulzer M, Maclean L, Dorkhen E, Grzbowski S. 1980. Epidemiologic health survey of grain elevator workers in British Columbia. Am Rev Respir Dis 121:329–336.

Chan-Yeung M, Enarson DA, Kennedy SM. 1992. The impact of grain dust on respiratory health. Am Rev Respir Dis 145:476–487.

Cohen VL, Osgood H. 1953. Disability due to inhalation of grain dust. J Allergy 24:193–211.

Corey P, Hutcheon M, Boder I, Mintz S. 1982. Grain elevator workers show work-related pulmonary function changes and dose–effect relationships with dust exposure. B J Ind Med 39:330–337.

Cotton DJ, Dosman JA. 1978. Grain dust and health 1. Host factors. Ann Intern Med 88:840–841.

doPico GA, Reddan W, Flaherty D, Tsiatis A, Peters M, Rao P, Rankin J. 1977. Respiratory abnormalities among grain handlers: A clinical, physiologic, and immunologic study. Am Rev Respir Dis 115:915–927.

doPico GA, Reddan W, Anderson S, Flaherty D. 1983. Acute effects of grain dust exposure during a work shift. Am Rev Resp Dis 128: 399–404.

Erhabor GE, Fatusi AO, Ndububa D. 1992. Pulmonary symptoms and functions in gas welders in Ile-Ife. Nig Med Pract 24(5/6):99–101.

Federal Environmental Protection Agency. 1991. Guidelines and standard for environmental protection control in Nigeria.

Femi-Pearse D, Adeniyi-Jones A, Oke AB. 1973. Respiratory symptoms and their relationship to cigarette-smoking, dusty occupations, and domestic air pollution: Studies in random sample of an urban African population. The WAJM, June:57–63.

Gahlinger PM, Abramson JH. 1999. Computer programs for epidemiologists: PEPI version 3.01. Wales: Brixton Books.

Hogan DJ, Dosman JD, Li KY, Graham B, Johnson B, Walker R, Lane PR. 1986. Questionnaire survey of pruritus and rash in grain elevator workers. Contact Dermatitis 14:170–175.

Ige OM, Onadeko OB. 2000. Respiratory symptoms and ventilatory function of the sawmillers in Ibadan, Nigeria. Afr J Med Sci 29(2):101–104.

Jinadu MK. 1980. Pattern of disease and injury among road construction workers in Plateau and Bauchi areas, Northern Nigeria. Ann Trop Para 74(6):578–584.

Jinadu MK, Malomo MO. 1986. Investigations into occupational health problems of bakery workers in Ile-Ife, Nigeria. Nig Med Pract 12(3/4):39–41.

Laraqui CH, Caubet A, Laraqui O. 2000. Prevalence of respiratory symptoms and evaluation of sensitization levels in traditional grain market workers in Casablanca. Rev Mal Respir 17(5):947–955.

Medical Research Council (MRC) Committee on the Aetiology of Chronic Bronchitis. 1960. Standard questionnaire on respiratory symptoms. BMJ 2:1665–1668.

Musk AW, Venable KM, Crook B, Nunn AJ, Hawkins R, Crook GDW, Graneek BJ, Tee RD, Farrer N, Johnson DA, Gordon DJ, Darbyshire JN, Newman-Taylor AJ. 1989. Respiratory symptoms, lung functions, and sensitization to flour in a British bakery. Br J Ind Med 46:636–642.

Ogakwu MAB. 1973. Pilot health survey among Enugu coal miners. Niger Med J 3(2):97–99.

Oleru U. 1980. Pulmonary functions of control and industrially exposed Nigerians in asbestos, textile, and toluene diisocyanate foam factories. Environ Res 23:137–148.

Omokhodion FO, Sanya AO. 2003. Risk factors for low back pain among office workers in Ibadan, Southwest Nigeria. Occup Med 53:287–289.

Pankova VB. 1992. Diseases of upper respiratory tract in workers in ''dusty'' jobs (abstract). Gig Tr Prof Zabol 7:9–12.

Phoon WO. 1988. Practical occupational health. Singapore: PG Publishing. pp 157–158, 411–416.

Pomeranz Y, Meloan CE. 1994. Food analysis: Theory and practice. New York: Chapman and Hall. pp 649–651.

Prichard MG, Ryan G, Musk AW. 1994. Wheat flour sensitization and airway diseases in urban bakers. Br J Ind Med 41:450–454.

Skoulas A, Williams N, Mariman JE. 1964. Exposure to grain dust II. A clinical study of the effects. J Occup Med 6:359–372.

Smith TA, Lumley KP. 1996. Work-related asthma in a population exposed to grain, flour, and other ingredient dusts. Occup Med 46(1): 37–40.

Smith TA, Parker G, Hussain T. 2000. Respiratory symptoms and wheat flour exposure: A study of flour millers. Occup Med 50(1):25–29.

Sofoluwe GO. 1977. Industrialization and the people's health (Abstract). Nigerian Medical Journal, special edition (Proceedings of the 1976 Annual Conference of the Nigerian Medical Association), 103–104.

Tse KS, Warren P, Janusz M, McCarthy D, Cheniack R. 1973. Respiratory abnormalities in workers exposed to grain dust. Arch Environ Health 27:74–77.

Viet SM, Bucan R, Stallones L. 2001. Acute respiratory effects and endotoxin exposure during wheat harvest in Northeastern Colorado. Appl Occup Environ Hyg 16(6):685–697.

Weiner JS, Lourie JA. 1969. Human biology: A guide to field methods. London: International Biological Programme. pp 7–8.

WHO. 1993. Recommended health based occupational exposure limits for selected vegetable dusts, report of a WHO study group. Tech Rep Ser 684:5–12.

Williams N, Skoulas A, Merriman JE. 1964. Exposure to grain dust 1. A study of the effects. J Occup Med 6:319–329.

Yach D, Myers J, Bradshaw D, Benatar SR. 1985. A respiratory epidemiologic survey of grain mill workers in Cape Town, South Africa. Am Rev Respir Dis 131:505–510.