Pak. J. Sci. Ind. Res. 2005 **48**(1) 23-27

Effects of Exposures to Cement Dust and Powder on Workers in Cement Distribution/Retail Outlets in Benin City, Nigeria

Ifeyinwa Flossy Obuekwe [ab]* and Lovette Isioma Okoh [a]

[a]Department of Pharmaceutical Microbiology, Faculty of Pharmacy, University of Benin, Benin City, Nigeria

[b]207-10807-47 Avenue, Edmonton, Alberta T6H 5J1, Canada

(received July 15, 2003; revised October 28, 2004; accepted November 2, 2004)

Abstract. This study investigated the effects of exposures to cement dust and powder on workers in fifteen cement distribution/retail outlets in Benin City, Edo State, South-West Nigeria. Forty workers from these retail outlets were initially surveyed by using detailed and open-ended questionnaires as well as oral interviews. Twenty of them were finally subjected to microbiological tests and medical examinations after series of oral interviews and depending on the physical effects of the cement dusts on their skins. Skin, nose and eye swabs, as well as sputum samples of the subjects were collected and cultured using various growth media. Organisms isolated included *Staphylococcus aureus, Branhamella catarrhalis, Bacillus* spp., *Klebsiella pneumoniae, Streptococcus* and *Proteus* species, and some fungi, including *Penicillium, Aspergillus, Trichophyton, Mucor* and *Epidermophyton* species. Chest radiographs were also done to detect the occurrence of silicosis (occupational asthma). The results of this study have shown that depending on the length and level of exposure to cement dust and powder, effects may range from contact dermatitis, skin rash, immediate or delayed irritation of the eyes, as well as chest infections.

Keywords: health hazard, cement dust, cement exposure, dermatitis, silicosis

Introduction

Cement can cause ill health on inhalation, and skin and eye contacts. Risk and extent, or severity of injury obtained, depends on the duration and level of exposure, as well as individual sensitivity. Thousands of labourers working at cement distribution outlets are exposed to the product in various forms, ranging from dry cement powder, cement dust, wet cement, and concrete everyday, being absolutely ignorant of the underlying health hazards and consequences of their occupation. Cement dust, released and inhaled during bag handling and bag 'dumping', can irritate the skin causing xerosis, which may result in scaling, itchiness, burning and redness (Yang *et al.,* 1996). Irritant contact dermatitis, as well as allergic dermatitis may develop. When cement is trapped, against the skin, it may take several months to heal and may involve hospitalization and skin grafts. The most hazardous effects of cement dust are on the lungs. In the short term, such exposures irritate the mucous membrane of the nose and throat causing choking, as well as difficulty in breathing (Al-Neami *et al.,* 2001; Yang *et al*.,1996). Cement has also been classified as a carcinogen due to its silica content.

Incidences of occupational health hazards amongst workers have been reported (Mwaiselage *et al.,* 2004; Alvear-Galindo and Mendez-Ramirez, 1999; Ng *et al.,* 1992). Workers in small-scale enterprises make up the second largest employment sector in developing countries. They confront very high social and health risks with poor working conditions, employment insecurity and minimum health care. Most of the workers even do not know that they are being exposed to numerous health risks. Reports show that more than 70% of workers at small-scale enterprises hardly know and believe that they are exposed to certain occupational health hazards (Fell *et al.,* 2003). The minimal occupational exposure standard for cement dust has been suggested to be 10 mg/m^3 total inhalable dust and 4 mg/m^3 total respirable dust. However, in developing countries, these standards are hardly maintained, particularly in small-scale enterprises. Therefore, workers at these sites are exposed to greater risks of developing job-related diseases (Al Neami *et al.,* 2001; Leffler and Milton, 1999; Yang *et al.,* 1993).

It has been reported that cement-related pneumocosis, e.g., silicosis, is attributed to the presence of silica in inhaled cement dust (Mengesha and Bekele, 1998; Ng and Lee, 1995). This is usually due to occupational exposure and inhalation of airborne crystalline silica. Silicosis is a disabling dust-related disease of the lungs. Even materials containing small amounts of crystalline silica may be hazardous if exposed to, in ways that produce high dust concentration, such as 'bag

*Author for correspondence; [b]present address;
E-mail: ifyobuekwe@yahoo.com

dumping' at cement depots during loading and unloading. Inhaling silica dust has also been seen to aggravate lung diseases, such as tuberculosis and lung cancer. It may be noted that pre-existing upper respiratory tract and lung diseases may be aggravated on inhalation of cement dust. Irritation of the moist mucous membranes of the nose, throat and upper respiratory systems also occur leaving unpleasant deposits in the nose. The risk of asthma attributable to occupational exposures is probably under-appreciated due to under-reporting and inappropriate use of narrow definition of exposure (Leffler and Milton, 1999).

This study investigates the health hazards associated with the exposure of workers at various cement distribution outlets to cement dust and powder in Benin City, Nigeria and also provides information to workers and employers on how to maintain a healthy work force and suggests effective measures to protect those at risk.

Materials and Methods

The study site. This study was carried out in Oredo and Egor Local Government Areas of Benin City, Edo State, South-West Nigeria. Fifteen major cement depots used as distribution and retail outlets located in the city were used for the study.

Subjects. The focus of this investigation was the effect of the length of exposure of each study-subject to cement dust. Forty subjects were initially used for the questionnaire-based study and twenty subjects were finally used for the experimental procedures. They were grouped into five, based on the results of an initial questionnaire-based study (Table 1). These workers were not temporary workers, for some had worked with the same company for more than five years.

Group A: those exposed to cement dust for less than 1 year.
Group B: those exposed for 2 years.
Group C: those exposed for between 3 to 4 years.
Group D: those exposed for more than 5 years.
Group E (the control group): those who had not worked or received exposure to cement dust previously.

It was ensured that the subjects used for this study had not been exposed to any other type of dust, like wood dust, grain dust, which may have caused occupational health hazards to the subjects previously. This precaution was taken to forestall any previous exposure to other forms of dust, which may have affected the subjects in a similar manner, in the past.

Sample collection. Sterile swabs were used to collect samples from the skin, nostrils and eyes of the twenty subjects investigated. The swab sticks were appropriately labelled and the samples were immediately shaken in normal saline, within 3-5 min of the collection. Samples were dispensed aseptically into other tubes and serial dilutions were made until a final dilution of 10^{-6} was obtained. The pour plate technique was used for the enumeration of microorganisms.

Plates were incubated at 37 °C for 24-48 h for the growth of bacteria and 5-7 days at room temperature (28±2 °C) for fungal growth. Swab samples of twenty subjects were further studied on sterile blood agar plates, which were incubated at 37 °C for 24 h for the detection of pathogens. Radiological examinations were done to detect the presence of fibrotic nodules or silica deposits on their lungs. Appropriate biochemical tests were used for the identification of all isolated microorganisms.

Results and Discussion

The initial questionnaire-based study showed a response rate of 90%. All the workers had no previous knowledge of the hazards related with exposure to cement dust and powder. 70% of the subjects reported one or more skin problems including rashes, blisters, fissures, burning, dryness, scaling and itchiness (Table 1). None of the subjects with skin problems reported lost work time, or physician visits for their problems; thus, they continued to work without seeking medical treatment, setting themselves up for life-long health problems. 65% reported one eye problem or the other, including redness, pain, burning and itchiness. These occurred only on contact with cement dust and powder. 30% of them reported shortness of breath on exertion, and this was experienced by those who had worked in the cement depots for 4 years and above. 90 % of these subjects were chronic cigarette smokers.

Table1. Results of the questionnaire-based study of the 40 subjects working at different cement distribution outlets in Benin City, Nigeria

No of subjects	Observations	(%)
30	Skin problems, including skin rashes, blisters, abrasions, fissures, burning, scaling, itchiness	75
Nil	Lost work time report or physician visits due to physical problems	Nil
26	Eye problems, including redness, pain, itchiness, burning	65
12	Shortness of breath and physical exertion	30
36	Chronic cigarette smokers	90

Table 2 shows the period of exposure of 20 workers investigated for microorganism studies. The total count of microorganisms isolated from the skin, eye and nose swabs of the subjects are shown in Table 3. The total bacterial count ranged from 2.5 x 10^5 to 5.0 x 10^6 colony forming units per millilitre (cfu/ml) zero to 8.9 x 10^7 cfu/ml, zero to 2.3 x 10^6 cfu/ml from the skin, nose and eye swabs, respectively. The isolated bacteria included *Staphylococcus aureus* and *Bacillu*s species, while the fungi isolated from skin swabs included *Penicillium, Mucor, Aspergillus, Trichophyton* and *Microsporium* species. Results from blood agar medium revealed the presence of pathogenic organisms, namely, *Staphylococcus aureus, Branhamella catarrhalis, Klebsiella pneumoniae* and *Streptococcus* species. (Table 4). Chest radiographs showed clear lung fields and normal heart sizes.

Table 2. Periods of exposure to cement dust and powder of the 20 workers investigated for microbiological examination

Periods of exposure	No of subjects	(%)
< 1 year	4	20
2 years	7	35
3-4 years	3	15
>5 years	3	15
Not exposed	3	15

Table 3. Total count of microorganisms isolated from nose, skin and eye swabs of the subjects

Subjects	Total count of microorganisms (cfu/ml)			
	Nose swab	Eye swab	Skin swab	
	Total bacteria	Total bacteria	Total bacteria	Total fungi
A1	8.9 x 10^7	2.3 x 10^6	2.35 x 10^6	1.75 x 10^6
A2	2.8 x 10^6	Nil	1.75 x 10^6	3.5 x 10^6
A3	3.5 x 10^5	1.05 x 10^6	4.5 x 10^6	1.8 x 10^6
A4	2.45 x 10^6	Nil	2.5 x 10^5	1.7 x 10^6
B1	4.5 x 10^6	6.0 x 10^5	1.65 x 10^6	2.3 x 10^6
B2	4.5 x 10^6	5.0 x 10^5	3.0 x 10^6	1.5 x 10^6
B3	4.6 x 10^6	1.7x 10^6	2.0 x 10^6	1.85 x 10^6
B4	3.35 x 10^6	5.0 x 10^5	8.5 x 10^5	2.25 x10^6
B5	1.27 x 10^7	1.0 x 10^5	3.38 x 10^6	3.4 x 10^6
B6	4.5 x 10^6	5.0 x 10^4	3.38 x 10^6	1.7 x 10^6
B7	2.8 x 10^6	1.5 x 10^5	4.1 x 10^6	1.1 x 10^6
C1	Nil	6.0 x 10^4	1.9 x 10^6	5.5 x 10^6
C2	3.9 x 10^6	2.2 x 10^6	5.0 x 10^6	3.4 x 10^6
C3	1.1 x 10^7	Nil	2.5 x 10^5	1.5 x 10^6
D1	2.35 x 10^6	7.5 x 10^5	2.5 x 10^5	7.0 x 10^5
D2	2.4 x 10^6	1.0 x 10^5	3.35 x 10^6	1.0 x 10^6
D3	3.3 x 10^6	5.0 x 10^4	2.75 x 10^6	1.5 x 10^6
E1	3.4 x 10^6	1.1 x 10^6	2.5 x 10^6	2. 15 x 10^6
E2	4.5 x 10^6	2.0 x 10^5	1.35 x 10^6	7.0 x 10^5

Table 4. Results from sputum cultures on blood agar plates

Subjects	Organisms isolated
A_1/A_2	*Staphylococcus albus, Branhamella catarrhalis*
A_3	*Staphylococcus aureus, Klebsiella* sp.
A_4	*Klebsiella* sp., *Branhamella catarrhalis*
B_1	*Streptococcus* sp.
B_2	*Staphylococcus aureus*
B_3	*Branhamella catarrhalis*
B_4	*Streptococcus* sp.
B_5	*Staphylococci, Streptococci*
B_6	*Staphylococcus aureus, Branhamella catarrhalis*
B_7	*Staphylococcus albus*
C_1	*Proteus* sp., *Staphylooccus albus*
C_2	*Streptococci, Branhamella catarrhalis*
C_3	*Branhamella catarrhalis*
D_1	*Staphylococcus aureus*
D_2	*Streptococcus* sp.
D_3	*Staphylococcus albus*
E_1	*Bacillus* sp., *Branhamella catarrhalis*
E_2	
Control	*Staphylococcus albus, Branhamella catarrhalis*

Results from this study have shown that workers in cement distribution/retail outlets in Benin City, Nigeria are exposed to very serious occupational health hazards. The most prevalent work-related health problem observed among the workers was contact dermatitis. Organisms such as dermatophytes and various bacterial species were isolated from skin samples, though some of the organisms were normal microbial flora of the skin. However, organisms such as *Candida albicans* can cause infections when the host defence mechanism is compromised and other opportunistic microorganisms whose rate and extent of proliferation and pathogenicity could be enhanced by the damaged skin barrier due to maceration of tissues, wounds and abrasions, chemical burns, and intravascular catheter. In this study, some of the workers were found to have experienced skin abrasions as well as chemical burns and were thus predisposed to infections such as dermatomycosis. Furthermore, skin injuries such as burns could predispose an individual to serious staphylococcal infections (Koneman, 1987). *Staphylococcus aureus* was iso-

lated from the skin swabs of all the subjects examined in this study. Cement is abrasive and contains some harmful chemicals that may burn and damage the skin, thus altering its integrity and predisposing workers to various microbial infections associated with contact dermatitis.

Chest radiographs of these subjects showed clear lung fields as well as normal heart sizes, thus the occurrence of silicosis may not have commenced. However, many of the subjects (30%) reported cases of shortness of breath on exertion (Table 1). Though lung function measurements were not carried out in this study, this observation could be interpreted as a pointer to the development of job-related lung dysfunction. *Branhamella catarrhalis* and *Staphylococcus aureus* were isolated from sputum samples in this study. Though these microorganisms are a part of the normal microbial flora of the respiratory tract, the presence of *Klebsiella pneumoniae* and *Proteus* species could be an indication of chest infections.

Smoking habit is one of the predisposing factors to the occurrence of job-related silicosis and 98% of the subjects in this study were found to be chronic cigarette smokers. Occupational asthma (silicosis) is diagnosed by a history of work-related symptoms and exposure to known causative agents. The diagnosis is usually confirmed by serial pulmonary function testing or inhalational challenge testing. The risk of silicosis attributable to occupational exposure is probably under-appreciated, due to under-reporting and to inappropriate use of narrow definition of exposure in epidemiological studies of attributable risk (Leffler and Milton, 1999; Ng *et al.,* 1992).

Skin problems from cement are widespread. Unfortunately, problems are often tolerated as part of the price of the work in this trade. Definitely, there will always be the occurrence of occupational diseases in different sectors of employment. However, there must be substantial variations in their incidences in various occupations. Work-related factors no doubt play a contributory role in these diseases and their prevalence is bound to vary with different occupations and types of employment. Workers hardly visit physicians for these diseases for fear of losing their jobs. The general level of tolerance permits the high rates of occupational skin problems to continue. There should be a change in this attitude, if these conditions must reduce to a manageable minimum.

Conclusion

This study observed that the workers were ignorant of the health hazards involved in their jobs, and therefore recommends that those working in cement distribution/retail outlets must have clear-cut information about the nature of their jobs, the possible hazards to health and ways of protecting themselves. Health education must be a priority with employers in all cement distribution outlets throughout the country.

One of the challenges is to convince cement product workers that it is possible for them to prevent occupational skin problems as well as occupational respiratory problems. They must, however, first realize how and when the skin and respiratory problems occur. Often, symptoms of lung dysfunction and rashes are downplayed or overlooked as a prelude to chronic disabling diseases. Actual challenge is the motivation, as the health impact of these occupations on the lives of the workers may play a key role. The prevention and monitoring of these work-related health problems present new challenges for the occupational health authorities. Employers also have a major role to play by providing facemasks to minimize exposure of their workers to cement dust and powder. Health education of workers should be a priority in all cement distribution/retail outlets in Nigeria. Research to provide protection and treatment for workers who are susceptible or who have already developed chronic occupational skin and respiratory diseases will be very timely.

References

Al-Neami, Y. I., Gomes, J., Lloyd, O. L. 2001. Respiratory illnesses and ventilatory function among workers at a cement factory in a rapidly developing country. *Occup. Med.* **51:** 367-373.

Alvear-Galindo, M. G., Mendez-Ramirez. 1999. Risk indicator of dust exposure and health effects of cement plant workers. *J. Occup. Environ. Med.* **41:** 654-661.

Fell, A. K., Thomassen, T. R., Kristensen, P., Egelard, T., Kongerud, J. 2003. Respiratory symptoms and ventilatory functions in workers exposed to portland cement dust. *J. Occup. Environ. Med.* **45:** 1008-1014.

Koneman, A. D. 1997. *Colour Atlas and Textbook of Diagnostic Microbiology*, 5th edition, J. B. Lippincott, Philadelphia, USA.

Leffler, C. T., Milton, D. K. 1999. Occupational asthma and contact dermatitis in a spray painter after introduction of an aziridine cross linker. *Environ. Health Perspect.* **107:** 599-601.

Mengesha, Y. A., Bekele, A. 1998. Relative chronic effects of different occupational dusts on respiratory indices and health workers in three Ethiopian factories. *Am. J. Ind. Med.* **34:** 373-380.

Mwaiselage, J., Bratvert, M., Moen, B., Mashalla, Y. 2004.

Cement dust exposure and ventilatory function impairment: an exposure-response study. *J. Occup. Environ. Med.* **46:** 658-667.

Ng, T. P., Lee, H. S. 1995. Further evidence of human silica nephrotoxicity in occupationally exposed workers. *Brit. J. Ind. Med.* **50:** 907-912.

Ng, T. P., Phoon, W. H., Lee, H. S., Ng, H. L., Tan, K. T. 1992. An epidemiological survey of respiratory morbidity among granite workers in Singapore: chronic bronchitis and lung function impairment. *Ann. Acad. Med. Singapore* **21:** 312-317.

Yang, C. Y., Huang, C. C., Chang, I. C., Lee, C. H., Tsai, J. T., Ko, Y. C. 1993. Pulmonary function and respiratory symptoms of portland cement workers in southern Taiwan. *Gaoxiong Yi Xue Ke Xue Za Zhi* **9:** 186-192.

Yang, C. Y., Huang, C. C., Chiu, J. F., Lan, S. J., Ko, Y. C. 1996. Effects of occupational dust exposure on the respiratory health of portland cement workers. *J. Toxicol. Environ. Health* **49:** 581-588.