Sick building syndrome among office workers in Mauritius

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ABSTRACT

A cross-sectional study was carried out to investigate the prevalence of sick building syndrome (SBS) among the office workers in Mauritius. Data were collected through self-administered questionnaires answered by 384 occupants in 25 randomly selected buildings. A walk-through investigation and some indoor climate variables were also monitored. All data collected were analysed using Epi-Info and SPSS softwares. *P* values less than 0.05 were considered significant.

Personal factors such as sex, allergy and active smoking were significantly related to SBS symptoms. Age of building, room and building damage indices, mechanical ventilation, ETS, job stress, VDU and paper work and were the other significant factors associated with SBS symptoms. Temperature, relative humidity, light, Gram-positive bacteria and presence of mites were the other significant factors, which influenced SBS symptoms in the final logistic regression model. In conclusion, SBS symptoms were common among office workers and were associated with personal, occupational and certain indoor environmental exposures.

INDEX TERMS

Sick building syndrome; Gender; Ventilation; Mauritius

INTRODUCTION

During the past few decades, an increasing number of reports of discomfort and health effects in the non-industrial workplaces have been reported. Researchers have used the term sick building syndrome (SBS) to describe non-specific symptoms such as irritation to eyes, skin and upper airways, headache and fatigue related to the indoor environment (Andersson, 1998). A multitude of risk factors including chemical, physical, biological and psychosocial have been associated with SBS that operate in a complex synergistic manner (Berglund *et al.,* 1996). Since no data on indoor air quality including SBS are readily available in Mauritius, the present study was undertaken to identify possible relationship between SBS symptoms with personal and indoor environmental conditions of the buildings.

METHODS

Buildings, occupied by public (government owned), parastatal (government subsidized) and private companies were investigated during the period January 1998 to December 2001. Buildings surveyed were selected according to type of organization, type of ventilation and office layout throughout the country. Most of them did not have any known air quality problems and were not known as 'sick buildings'. This restriction was aimed at avoiding recollection of complaints. Building ventilation categories included natural ventilation (buildings with openable windows but no mechanical airflow) and mechanical ventilation, which included heating, ventilating and air conditioning and electric fans.

The study was based on a questionnaire adapted from Wilson and Hedge (1987). It was written in English and was pre-tested twice among office workers of three different workplaces. It was assessed and evaluated for validity by a group of eminent persons including a social scientist, an occupational health physician, a chest specialist and an

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environment health scientist. The self-report questionnaire was distributed in each building before monitoring of indoor air quality. Questions based on personal characteristics, work environment and demographic factors, perception of symptoms, indoor climate, and psychosocial and physical conditions at work were included. Presence of dampness such as any signs of water damage, growth of mould and signs of damaged floor covering observed in the workers' offices and the whole building was also answered. Building and room damage indices were, therefore, constructed and the value ranged from 0 to 3.

A letter was mailed together with a copy of questionnaire and information about the scope of the survey to the officer responsible in each building for participation in the study. Workers who spent more than half their working hours in the office during the preceding three months were included in the study population. The confidential, self-administered questionnaire was distributed individually after an explanation of it and was collected a week after or immediately on completion.

Walk-through investigation of the building was conducted to obtain information on the history of the building use and on factors that can influence indoor air quality. During this exercise, observations were made on the building and room characteristics. While indoor environmental assessments included measurements of biological, chemical and physical parameters using standard methods and were made in the same week that the questionnaire .was distributed to the office workers. Questionnaire survey was always completed before the different parameters were measured; thereby avoiding that knowledge of the results of the exposure measurements influenced the respondents.

All analyses were performed using Epi Info (Centres for Disease Control and Prevention, Georgia) and SPSS (SPSS Inc., Chicago, IL) statistical software packages. The Chi-square test was applied in the bivariate analysis. Multivariate statistical analysis was done by multiple logistic regressions, and adjusted odds ratios with 95% confidence intervals (OR; 95% CI). SBS symptoms were grouped as follows; CNS (headache, excessive mental fatigue, nervous (irritability), unusual lethargy, loss of concentration, nausea and dizziness); eye (dry eyes, watery eyes, irritated eyes and tired, strained eyes); nose (runny nose, stuffy nose and sneezing); throat (sore irritated throat and hoarseness); lower respiratory (chest tightness, wheezing and coughing) and skin (irritation, rashes and dry skin) symptoms. The possible personal confounding factors such as age, sex, current smoking and atopy were controlled. Differences were accepted as statistically significant when the associated *P* value was less than 0.05.

RESULTS

Four hundred and twenty-two occupants out of a total population of 796 office workers responded and returned their questionnaires; thus giving response rate of 53.0%. As 38 of these were grossly incomplete, the final sample consisted of 384 participants. Table 1 summarizes the findings of the personal, job and office characteristics, and the indoor climate perception of both female and male respondents who participated in the study. Majority of them were married and had one to three children. There were about four times more smokers among males than females.

Table 1 Characteristics of study participants and office buildings

Characteristics	Sex distribution (%)	
	Male (n = 217)	Female (n = 131)
Personal characteristics		
Sex	56.5	43.5
Allergy	18.9	21.0
Active smoking	19.8	4.80
Marital status		
Single	37.8	26.9
Couple	61.8	72.5
Number of children		
0	6.00	7.20
1–3	59.4	54.5
>3	34.6	38.3
Indoor climate perceptions		
High temperature	59.0	61.7
High relative humidity	39.2	50.9
Little air movement	55.8	65.3
Insufficient ventilation	48.8	50.9
Distracting ambient noise	61.8	58.1
Unpleasant odour	43.3	57.5
Dusty air	57.1	50.3
Dim light	24.9	28.7
Glare problems	33.2	40.1
Office characteristics		
Damp conditions		
Water damage	20.7	12.0
Mould growth	18.4	12.6
Damaged floor	20.7	14.4
Open shelves	71.4	70.7
Dusty shelves	51.2	52.7
Dusty floor	94.5	97.6
PVC floor	42.9	30.5
Cleaning frequency		
<2/ week	3.7	8.4
≥2/week	96.3	91.6
Wall to wall carpeting	64.5	70.7
Presence of curtains/ textiles	55.8	48.5
ETS	23.5	18.6

The most prevalent discomforts of perceived indoor air quality (>48%) was humid air, warm temperature, little air movement, insufficient ventilation, distracting ambient noise and unpleasant odour in the air. Apart from dusty air and distracting noise, women reported relatively more complaints of the inadequate indoor climate than men. However, in the final logistic regression model, all these complaints were statistically significant with different group of SBS symptoms (data not shown).

Nearly 18–21% of the males and 12–14% of females were exposed to damp conditions such as presence of mould growth, water damage and damaged floor covering in their immediate office environment. Majority of the respondents were found in offices, which had wall-to-wall carpeting and open shelves; about 50% of the latter were dusty. Almost all the male and female workers were exposed to dusty floor. Males were relatively more exposed to curtains/textiles (≈56%), PVC floor (≈43%) and ETS (≈24%). Analysis of workers' symptom profiles **(**data not shown) showed that both male and female workers complained mostly of headache across forehead, excessive mental fatigue, nervousness, unusual tiredness/lethargy, lack of concentration/forgetfulness, irritated and tired/strained eyes and sneezing in the prior month. However, the prevalence of some of the SBS symptoms was significantly higher among women than men. Our results also show that personal factors such as gender, allergy and active smoking influenced symptom's prevalence.

Multiple logistic analysis (Bholah *et al*, 2000) of the significant relationship between occupational factors and any group of SBS symptoms revealed that building age (<30 years) was related to eye (P<0.05) and skin (P<0.05) symptoms. Mechanical ventilation was found to influence CNS and respiratory symptoms among the workers. Both building ($P < 0.01$) and room ($P < 0.05$) damage indices were related to eye symptoms. However, building damage index also had significant association with lower respiratory symptoms ($P < 0.01$). Among the associations between the physical factors and any type of symptoms, there was significant difference between room temperature and eye symptoms ($P < 0.05$). Relative humidity and light was found to influence mainly CNS ($P < 0.05$) and eye ($P < 0.05$) symptoms respectively. Gram-positive bacteria were the only biological factor that showed significant association with eye ($P < 0.05$) and lower respiratory ($P < 0.05$) symptoms. There was also significant difference between mite and lower respiratory or skin symptoms. However, the investigated chemical parameters such as carbon dioxide, carbon monoxide, nitrogen dioxide did not influence SBS symptoms.

DISCUSSION

The results of the present study have revealed that among personal factors assessed, there were generally consistent findings associating symptoms with female gender, allergy and smoke (Bholah *et al.*, 2000, Hedge *et al.*, 1996). Complaints such as warm temperature, dim lighting, glare problems, distracting ambient noise and dusty air were found to be the commonest components of a perception of poor indoor air quality. The present results were consistent with our on-site walk-through investigation, which also showed visible dust on carpets, the open shelving and files. Studies have shown that the level of dust to which office workers are exposed can be four to five times higher than the ambient airborne levels, since people create their own 'dust cloud' in the course of their work by stirring up settled dust (Berglund *et al.*, 1996). Most of these variables were related to the type and poor quality of the ventilation in the buildings. Occupants working in mechanically ventilated buildings significantly reported a higher prevalence of SBS symptoms than those exposed to natural ventilation. These results are in agreement with earlier studies (Hedge *et al.*, 1996; Sundell *et al.*, 1994).

Moreover, our data are consistent with other studies, which have reported that the age of building is associated with the prevalence on SBS. Many of theses symptoms are thought to stem from exposure to volatile organic compounds emitted from new buildings such as paints. However, VOCs were not examined in this study. Observations about dampness are in agreement with earlier studies and previous reports where a relationship was found between signs of building damage and increases in eye and upper airway symptoms (Bholah *et al*., 2000, Bholah and Subratty, 2003, Norback *et al.,* 1994). Other researchers have also reported an increase of respiratory symptoms in damp or mouldy dwellings (Rylander and Jacobs,

1994, Rylander, 1998). Moreover, Bholah and Subratty (2003) were able to demonstrate a dose-response relationship between dampness and respiratory symptoms by constructing a dampness index and these findings are in accordance with two earlier studies done in Taiwan and Sweden (Wan and Li, 1999, Engvall *et al*., 2001).

Dampness allows the growth of various microorganisms including mites (Burge, 1990; WHO, 1983). Our study also revealed similar findings. However, presence of mites in the offices was strongly related to fewer respiratory and skin symptoms**.** Various microorganisms were also present in the indoor environment of both naturally and mechanically ventilated buildings, but only Gram-positive bacteria were related to symptoms. Conversely, other studies have shown that inhalation of dust particles containing microorganisms especially Gram-negative bacteria and their endotoxins from building structure produces non-specific symptoms such as reactions of irritation, headache, and fatigue (Norback *et al*, 1994, Rylander, 1998).

Full-time computer operators reported more symptoms than infrequent users and non-users. Associations between computer use and SBS have been confirmed in several studies (Sundell *et al*., 1994; Bholah *et al.*, 1999, 2000). Environmental changes resulting from computer use, such as the electrostatic field generated by VDT screen, may attract more particulate contaminants into a worker's breathing zone, and this may be responsible for the increase in SBS symptoms reports among computer users (Hedge *et al.*, 1996).

CONCLUSION

The present study, which is the first of its kind to be undertaken in Mauritius shows that personal factors such as gender, active smoking and allergy; occupational factors including age of building, type of ventilation, dampness, ETS, VDU, paper work and the psychosocial work conditions like job stress were associated with reporting of SBS symptoms. Our findings suggest that measures should be taken to reduce building-related complaints and symptoms by observing the most appropriate indoor environmental climate and reducing building dampness and microbial growth in the buildings. Further research should be carried out to do an in-depth study of the different factors causing the health effects among occupants of the indoor environments.

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