Sick building syndrome in Mauritius: a need for concern

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ABSTRACT
During the past few decades various symptoms and illnesses have been attributed to non-industrial indoor environments. Problems associated with the indoor environment are a common health issue faced by clinicians; generally, these complaints are regarded as being due to sick building syndrome. Mauritius is a small island with a subtropical climate. Mauritius is also a country where the prevalence of bronchial asthma among the population is high. No data on the sick building syndrome were available for Mauritius. This paper intends to present results from studies undertaken on the sick building syndrome in office premises and domestic interiors in Mauritius.

INDEX TERMS
Sick building syndrome; Indoor air quality; Symptoms; Ventilation; Mauritius

INTRODUCTION
Sick building syndrome is an environmental health issue that has received much attention over the years (Vincent *et al.,* 1997). This, as originally defined by the World Health Organisation (WHO, 1987), refers to non-specific symptoms including eye, nose and throat irritation, mental fatigue, headaches, nausea, dizziness and skin irritation, which seemed to be linked to indoor climate problems (Berglund *et al.,* 1996). The syndrome has no proper medical definition and pinning down a building with this problem can prove to be difficult (Valbjorn *et al.,* 1990). Mauritius is a small island and its sub-tropical climate, densely built environment, and energy conservation requirements pose special constraints to the building industry in ensuring that ventilation and indoor air quality within the fully enclosed offices remain acceptable. In tandem with rapid urbanization and a newly industrialized economy, the prevention of ill health in the offices and residential buildings presents a growing challenge to medical practitioners and building managers. Since no data on indoor air quality including SBS and its health impact among workers are readily available in Mauritius, the present study was undertaken to identify a possible relationship of these symptoms (if any) to personal and indoor environmental factors associated with ventilation systems in office buildings and residential interiors.

METHODS
Twenty-one office buildings, occupied by public and private companies were investigated during the period January to December 1999. A self-report questionnaire was distributed in each building before monitoring of indoor air quality, Questions on personal characteristics, work environment and demographic factors formed part of the questionnaire. Other factors of relevance included indoor climate at work, perception of symptoms, and psychosocial and physical conditions. A detailed walk-through inspection was also conducted to obtain information on the history of the building use and factors, which could influence indoor air

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quality. During this exercise, observations were made on the building and room characteristics. Indoor environmental measurements were monitored for relative humidity (Griffin sling psychrometer, B.S 2842), air temperature (digital temperature meter SEI 26 Solex, temperature accuracy ± 0.8°C, range 0–60°C), air velocity (Lutron anenometer, AM/4201, speed range 0.4–30 m/s), noise (Griffin sound level meter, detection limit, 0.1 dB(A) and range 40–110 dB(A)), light (Philips Harris luxmeter Log range 0–1000 lux). The levels of carbon dioxide, carbon monoxide and nitrogen dioxide (Detectawl Toxic Gaztell Portable gas detectors, DGT model and range 0–1000 ppm) were also measured.

Residential Interiors

A cross-sectional study was carried out from September 2000 to April 2001 on a convenient sample of 300 participants living around different regions on the island. The survey was conducted using a slightly modified version of the questionnaire by Bholah *et al.* (1999).

Data Analysis

Statistical analyses were performed using SPSS statistical software.

RESULTS

Questionnaire Survey

The 21 major office buildings surveyed were mostly 1–8 floor complexes with an age of occupancy of at least 5 years. The 254 selected offices typically utilized open concept workstations and a few enclosed rooms for senior staff. A total of 635 questionnaires were distributed to the workers but 331 were returned, giving a response rate of 52.1%. As 29 of these were grossly incomplete, the final sample consisted of 302 participants (47.6%). They comprised 44 managers (14.6%), 24 professionals (7.9%), 64 technicians (21.2%), 97 clerks (32.1 %), 57 secretaries (18.9%) and 16 other officers (5.3%).

It was noted that certain factors such as allergy, region of work, working hours, occupation, sector of employment (public and private), age of building, and presence of pests and insects, were equally distributed between both sexes. It was also found that personal factors such as gender ($p < 0.05$), active smoking ($p < 0.01$) and age influenced the prevalence of symptoms among workers ($p < 0.05$). However, the age of the female gender was significantly related to the type of ventilation ($p < 0.05$). Lower position in employment ($p < 0.05$), type of occupation ($p < 0.05$) and the age of the building being between 1 and 25 years ($p < 0.01$) seemed to influence the prevalence of symptoms among both sexes.

Among occupational factors, buildings between 1 and 25 and those older than 50 years were also associated with SBS. Cleaning practices ($p < 0.05$), wall-to-wall carpeting ($p < 0.05$) and presence of pests and insects ($p < 0.01$) were equally found to influence SBS symptoms. Moreover, it was noted that VDT use influenced the prevalence of symptoms. Female workers ($n = 47$, 39.5%) working for longer periods (>4 h) with VDT were found to be highly vulnerable ($p < 0.05$). Female occupants (49.6%) were found to handle more papers and consequently showed high, significant relation with SBS symptoms ($p < 0.01$).

Workers reported that physical conditions, such as ‘too little air movement’ ($p < 0.01$), ‘air too humid’ ($p < 0.01$), ‘unpleasant odour in air’ ($p < 0.01$) and ‘dusty air’ ($p < 0.05$) were factors significantly affecting their quality of life at the workplace. However, our results also showed that most of the workers were satisfied with their job ($p < 0.05$).

Regarding residential, domestic interiors, of the 174 houses surveyed, health symptoms such as headache, nervousness, excessive mental fatigue, lack of concentration, dizziness, sleeping problems, unusual tiredness and joint pain were more widespread among male residents. Ventilation system, type of dwelling, dwelling material and age of the building were important factors affecting the residents. A comparison of the relationship between exposure factors at home and symptoms revealed that the amount of time spent indoors (>4 h/day) was associated with symptoms such as watery eyes, skin rash and body-ache.

DISCUSSION

This study shows that personal and work factors were possible risk indicators for SBS symptoms. Among personal factors assessed, there were generally consistent findings associating symptoms with age, female gender and smoke (Relich *et al.,* 1997). However, in contrast to other reports, allergy did not seem to influence SBS prevalence among females Burge, 1992). It was noted that certain parameters such as location of building (region), working hours, place of employment and type of building were not found to be likely contributing factors to the sick building syndrome.

Furthermore, there was a correlation between SBS symptoms and female workers in respect of a number of other exposure factors in the work environment. Apart from being more often exposed to tobacco smoke, they (mostly clerks and secretaries) were more likely to have routine jobs and handled more paper work. Hence, these people were found to be more at risk of developing SBS symptoms (Stenberg and Walls, 1995).

Presence of photocopiers, laser printers and other equipment in the immediate working environment of the workers, especially of the mechanically ventilated buildings, was also found to influence SBS symptom prevalence in both sexes (Hedge *et al.,* 1996). Studies have shown that these devices (especially when not properly maintained) may produce ozone gas, which is an irritant to the respiratory tract (Copenhagen, 1983).

The present results are consistent with our on-site walk through inspection, which showed visible dust on carpets, the open shelving and files. Studies in other developed countries have shown that the level of dust to which office workers are exposed can be 4–5 times higher than ambient airborne levels, since people create their own ‘dust cloud’ in the course of their work by stirring up settled dust. Cleaning practices also seemed to be an important factor that influenced the prevalence of symptoms in both sexes. Office cleaning, therefore, could be an important source of airborne particulate matter if the equipment used did not filter out fine particles or otherwise prevent them from becoming airborne.

Women reported significantly more symptoms in mechanically ventilated buildings than those in a naturally ventilated work environment. This is also consistent with a number of other studies (Mendell, 1993). In mechanically ventilated buildings, especially air-conditioned buildings, the air may pass through several potential sources of contamination (e.g. ducts, humidifier, chiller), whereas in naturally ventilated buildings, ventilation depends solely on operable windows and doors**.** However, the association between the efficiency of the different types of ventilation and outdoor airflow rates and sick building syndrome has yet to be studied.

Measurements of indoor quality were not found to be reliable predictors of the symptoms. Although low thermal comfort (too little air movement and air too humid) was reported by the workers in the questionnaire survey, no obvious relation of symptoms was noted to fluctuations in temperature, relative humidity and air movement beyond recommended levels (Valbjorn, 1990). The associations between measured physical environmental conditions and symptoms were not very strong. This suggests that these variables did not determine symptom reports. However, in this study microbiological contaminants were not measured, whilst recent studies suggest that these may be more highly correlated with symptoms (Rylander, 1997).

Our studies also show that personal and home factors were possible risk indicators for SBS symptoms among residents in Mauritius. This could possibly be due to the changing life-style of the population with people staying indoors for relatively longer periods being more exposed to the home microenvironment. However, no significant relation was found between region and SBS. This may be due to the fact that Mauritius is a small country with only slight variations in the environment throughout the island.

Our study tends to support a relationship between exposure factors and SBS symptoms in domestic interiors in Mauritius. Intense TV use among certain participants as well as spending at least 14 h indoors daily were found to be associated with SBS symptoms.

Individuals in the indoor environment are usually exposed to complex mixtures rather than a single pollutant. Thus, it would seem highly probable that certain allergy problems reported by the participants could be related to various emissions from the potential sources of volatile organic compounds in the domestic environment, including building materials, furniture, household maintenance products, products of personal hygiene or ETS, which contribute to a large extent to indoor air pollution. Interior environments, unless scrupulously clean, offer a wide variety of substrates for growth of bacteria and fungi. Damp, non-living organic material and superficial condensation, interstitial condensation within porous building materials such as concrete, brick and plaster, may provide a reservoir allowing fungal growth. Besides, the volatiles, which are produced by fungi, are frequently evident as 'mouldy smells'. These volatiles are mostly complex mixtures of alcohols, esters, aldehydes, various hydrocarbons and aromatics. Symptoms like headaches, and eye, nose and throat irritation or fatigue have been associated with volatile compounds produced by fungi.

In conclusion, our work is the first to report the presence of SBS in office and domestic interiors in Mauritius. There is need for a strong inter-disciplinary collaboration between health care professionals as well as building specialists when it comes to designing of buildings and houses especially in a country where the microclimatic conditions are ever changing and the prevalence of asthma and allergy is high.

The present study, which is the first of its kind to be undertaken in the island, shows the presence of SBS symptoms in Mauritius**.**

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