PREVALENCE OF THE SICK BUILDING SYNDROME AMONG OFFICE WORKERS BEFORE AND AFTER MOVING IN A BUILDING WITH ABOVE STANDARDS VENTILATION SYSTEM

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ABSTRACT

A natural experiment was carried out in office workers. The prevalence of symptoms was measured using a self-administered questionnaire in Feb 91, when workers were located in 5 conventional mechanically ventilated buildings with sealed windows and again, in Feb 92, six months after workers moved in a single building with above standards ventilation systems. The symptoms had to be present at work and at least 2-3 times per week. Response rate was 85% each year. A total of 1010 office workers completed the questionnaires in Feb 1991 and in Feb 1992. After controlling for personal, occupational, psychological and building-related characteristics, the prevalence odds ratios (95% CI) were as follows for each reported symptom: 1.3 (1.0,1.7) for eyes, 1.8 (1.4,2.4) for nose and throat, 2.4 (1.5,5.3) for respiratory, 2.0 (1.2,3.3) for skin and 1.3 (1.4,2.6) for fatigue. These results suggest that important improvements in the ventilation systems of buildings with sealed windows could reduce the prevalence of symptoms.

INTRODUCTION

In the last 15 years, a large number of office workers have complained of a similar set of symptoms, commonly known as the Sick Building Syndrome (SBS). In 1982, the World Health Organization defined the SBS as "an increase in the frequency of building occupant reported complaints associated with acute non-specific symptoms (eyes, nose or throat irritation, headache, fatigue, nausea) in non-industrial environments that improve while away from the buildings"[(1)].

To date, there has been no systematic picture of simple causal agents in the SBS. Although biological and chemical air contaminants have been reported in some episodes, investigations of indoor air pollutants in epidemiological studies have failed to produce significant findings [(2-4)].

In most of the epidemiological studies, the increased prevalence of symptoms has been clearly related to the occupancy of a building with mechanical ventilation and sealed windows [(5)]. The SBS has also been attributed to inadequate supply of outdoor air to the indoor office space. Personal, occupational and psychological characteristics have been identified as independent determinants of the SBS but cannot explain completely the increased prevalence of symptoms.

The present study was designed to measure the effect of above standards ventilation systems on the prevalence of symptoms associated with the SBS among office workers after

controlling for personal, occupational, psychological and building-related characteristics.

METHODS

Design

A natural experiment was carried out in office employees working in mechanically ventilated buildings. The prevalence of symptoms and other variables were first measured in February 91, when workers were located in 5 conventional mechanically ventilated buildings and again, in February 92, six months after workers moved in a single building with above standards ventilation systems.

Study Population and Buildings

All workers employed in a large governmental organization were invited to participate. Workers whose jobs involved being located outside of the buildings studied and workers on long term leave were excluded. No history of complaint had come to the public health attention from this working population. All of the buildings had mechanical ventilation, controlled humidification and sealed windows. Of the five conventional buildings, two had a ventilation system with constant flow and three with variable flow. The new building had three main ventilation systems with constant flow and eighteen ventilators to supply air independently at each half floor. The five conventional buildings could not guarantee the current ASHRAE standard for minimum supply of outdoor air and maintain a percent of relative humidity at 30%, while the new building was conceived to go beyond these standards.

Data collection

Based on questionnaires used in previous published studies on the SBS, a questionnaire was developed for the purpose of the present study. Questions on symptoms related to their frequency and whether they occurred at work or outside work. Seven groups of symptoms were considered (see table 2, first column). Symptoms were considered prevalent when they occurred only at work and at least 2-3 times per week. All questionnaires were self-administered at work during regular working hours. The employer had previously agreed to allow workers to take time off during working hours to fill out the questionnaire. Questionnaires were distributed at each worker's desk and, on two further occasions, for those who had not returned them. The questionnaire also contained questions on personal characteristics, medical and work history, perception of office environment[6] and psychological characteristics of work[7]. Workers returned the questionnaire through an internal mailing system in a sealed envelope pre-addressed to the research group.

Analysis

The analysis was conducted on a matched population which means only among workers who participated in 1991 and in 1992. Prevalence odds ratios for symptoms and their 95% confidence intervals were used as the effect measure[8]. Prevalences measured in 1991 were considered as the referent categories. Prevalence odds ratios were adjusted by logistic regression for building-related characteristics which were different in 1991 when compared to 1992. The SAS statistical package was used for all analyses[9].

RESULTS

Response rate was 85% each year. A total of 1010 workers, 56% of whom were females,

77% aged less than 45 years old and 76% non smokers, completed the questionnaire in February 1991 and in February 1992.

Table 1 gives the distribution of the study population by category of psychological and building-related characteristics. Psychological job demands, decision latitude, job strain and co-workers social support were comparable each year. Some building-related characteristics were slightly different.

Table 1. Psychological and building-related characteristics among office workers before and after moving in a new building with above standards mechanical ventilation systems

Characteristics	Buildings with mechanical ventilation systems, humidification and sealed windows	
	Conventional buildings n = 1010	New building n = 1010
	(%)	(%)
Psychological characteristics		
- High psychological job demands	53.4	54.1
- Low job decision latitude	55.8	53.3
- High job strain	25.7	25.7
- Low work social support	30.8	30.5
Building-related characteristics		
- window proximity (<3m)	62.5	36.9
- photocopier proximity (<5m)	17.7	9.3
- work at video display (≥20 hrs/wk)	38.5	38.1
- inappropriate noise	45.0	55.0
- inappropriate lighting	15.1	7.7
- inappropriate space privacy	59.0	62.2
- uncomfortable chair	19.1	9.6

Table 2 shows prevalences of symptoms and prevalence odds ratios (PORs) along with their 95% confidence intervals for before and after moving in the new building. The prevalence of symptoms was higher before than after moving in the new building with the exception of headache and difficulty to concentrate.

Table 2. Prevalence (%) and prevalence odds ratios (PORs) for reported symptoms* among office workers before and after moving in a new building with above standards ventilation systems

Symptoms	Prevalence of symptoms		Crude POR	Adjusted POR‡
	Conventional buildings† n = 1010	New building† n = 1010	(95% CI)	(95% CI)
Headache	6.9	5.1	1.38 (0.95-2.00)	1.19 (0.78-1.80)
Nose, throat	22.0	12.2	1.98 (1.56-2.53)	1.83 (1.40-2.39)
Eyes	18.0	13.4	1.41 (1.11-1.80)	1.27 (0.96-1.66)
Lower respiratory tract	2.7	1.2	2.50 (1.23-5.06)	2.44 (1.12-5.34)
Skin	6.2	2.8	2.26 (1.43-3.56)	1.99 (1.20-3.30)
Difficulty to concentrate	18.7	18.8	0.98 (0.78-1.23)	1.02 (0.79-1.32)
Fatigue	15.3	8.3	2.05 (1.53-2.73)	1.90 (1.38-2.61)

* Symptoms occurring only at work and at least 2-3 times per week
† Buildings with mechanical ventilation systems, humidification and sealed windows
‡ Adjusted by logistic regression for noise, lighting, uncomfortable chair, window and photocopier proximity

DISCUSSION

The results of this study conducted in a large population of office workers suggest that important improvements in the ventilation systems of a building with sealed windows could reduce the prevalence of symptoms associated with the SBS.

Previous studies found that reports of the SBS are not solely a function of the building ventilation system, but are also associated with a variety of individual, organizational, environmental, psychological and perceptual factors[2,10-12]. In the present study, the use of a matched population eliminates some of the potential bias introduced when comparing two or more populations of workers which could differ in terms of individual, psychological and organizational characteristics. Furthermore, when organizational and psychological factors were quantified, it was found that they were similar each year. Therefore they were not adjusted for in the regression analysis. However, because the study was a natural experiment, some building-related characteristics were different before and after moving in the new building. Characteristics such as proximity of a window and a photocopier, lighting, noise and comfort could have caused confounding. However, after controlling for these characteristics, there was still a significant decrease in the prevalence of symptoms.

Selection bias among workers seems unlikely, as response rate was high each year. Another potential limitation of the present study is the use of a self reported questionnaire to measure symptoms. This limitation is shared, however, by all studies on the SBS conducted to date. Bias potentially associated with self report was minimized in the present study, given that buildings were selected independently of workers' complaints. Awareness of the study and the attraction of a newly constructed building could also have increased worker's concerns and frequency of reported symptoms in the conventional buildings. This potential bias cannot be ruled out. However, awareness of the study was limited in that the study hypothesis was not known of the participants. Furthermore, we believe that the 6 months elapse of time allowed between measures of symptoms and the date of moving, both, before and after the move, minimize the probability of workers' reports being biased by the attraction of a newly constructed building. There was no evidence after six months that adjustment in the ventilation systems and the presence of synthetic materials (paint, carpet, furniture) were a problem. These factors would have led to a decrement of the measured effects.

Recently a randomized, experimental, double-blind, cross-over study found no association between reporting of symptoms and ventilation levels[13]. The results of our study suggest that, apart ventilation levels, there may be other ventilation parameters which are of importance in influencing the prevalence of symptoms in occupant of buildings with sealed windows.

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