Is the Wellington medical school facility a sick building?

Jesse Gale
Julian Crane
Robert Siebers
Philippa Howden-Chapman
Wellington School of Medicine and Health Sciences
University of Otago

Robyn Phipps
Institute of Technology and Engineering
Massey University

ABSTRACT

The sick building syndrome (SBS) is an occupational health description that indicates a high prevalence of certain symptoms in a building's occupants. This article describes a pilot study that was undertaken to determine whether Wellington School of Medicine and Health Sciences (WSMHS) facilities suffered SBS. An internationally validated questionnaire was delivered to staff electronically. The response rate was 60%. The prevalence of work related symptoms was found to be similar to international studies (mean 1.76 symptoms per person, from list of five), with a similar detrimental effect on productivity. As in previous research, gender and job were found to be major contributing factors to SBS symptoms, but no locations within WSMHS were found to be better or worse than others. Environmental causes of SBS may vary widely between nearby work areas. Detailed, systematic study is required to elucidate environmental causes of SBS in New Zealand.

Keywords

Sick Building Syndrome, indoor air quality, gender, occupation

Jesse Gale is a Trainee Intern at the Wellington School of Medicine and Health Sciences, and President of the New Zealand Medical Students' Association. In 2006, Jesse will begin his first year house surgeon post at Nelson Hospital and pursue his interest in ophthalmology.

INTRODUCTION

The term sick building syndrome (SBS) is applied to a building in which certain non-specific symptoms are more common amongst the occupants than in comparable buildings[1]. The symptoms are present when the person is in the affected building, and alleviated when the person is away from the building. It is a heterogeneous clinical picture, comprising headache, lethargy, with dryness or irritation of the eyes, nose, throat or skin[2]. The symptoms are common amongst office personnel (over 80% experience one or more), but generally occur with low severity, and in different combinations[3]. The SBS is defined by prevalence: sick building occupants suffer from an average of more than 2.5 work-related symptoms each (occurring at least twice in 12 months, improving away from the building, from a list of five symptoms) while the healthiest buildings have fewer than 1.5 building-related symptoms per occupant per year[3]. Thus, the diagnosis of SBS requires systematic research across all building occupants.

Sick building syndrome is due to the interaction between many personal factors (e.g. gender, medical history), occupational factors (e.g. clerical work, proximity to photocopiers, computers), psychosocial factors (e.g. stress, job satisfaction), and environmental factors (e.g. indoor air quality, lighting, temperature, crowding). All of these (and more besides) are associated with, and seem to contribute to, SBS symptoms[3-9]. Some of these factors may be the primary causes of SBS, but others will be simply confounding relationships, indicators of susceptibility, or markers of exposure.

There have been SBS-like complaints about the work environment at the Wellington School of Medicine and Health Sciences (WSMHS) for many years, the buildings are typical of those that suffer SBS, and it has been studied in the past[10]. This study aimed to determine whether WSMHS suffered SBS using internationally standardised methods, and to describe the work locations and other factors that were associated with these complaints.

METHODS

The target population were staff and postgraduate students working at least ten hours per week in the two main buildings of WSMHS. Workers who spent less time in WSMHS would introduce confounding effects from other workplaces. The Academic and Link buildings stand adjacent, contain a wide variety of work environments, and are supplied by three sealed mechanical ventilation systems: designated A, B (Academic) and C (Link). Only A and B systems contained humidifiers, and system A recycles 30% of the air returning from office spaces, but otherwise the systems had equivalent construction.

The study was approved by the Wellington Regional Ethics Committee, and was supported by the Dean, Professor Nacey.

A questionnaire was developed from that of the SBS advisory group to The Royal Society of Health (RSH) of the United Kingdom. The RSH questionnaire

was designed by an international committee to standardise the screening of buildings for SBS, and was validated both in terms of reliable prevalence estimates and the detection of clinically accurate symptoms[3 11 12]. The questionnaire was piloted on six staff outside of the buildings, and minor comments were incorporated.

The questionnaire contained questions on symptoms, and potentially associated variables (i.e. personal, psychosocial, occupational factors and location). The eight SBS symptoms investigated were 1) dry eyes, 2) itchy or watery eyes, 3) blocked nose, 4) runny nose, 5) dry throat, 6) headache, 7) lethargy and 8) dry, itchy or irritated skin. Symptoms were only included if they were confirmed as "better on days away from WSMHS." Each symptom had to have occurred on at least two separate occasions in the preceding 12 months.

The questionnaire was delivered as a Microsoft Word attachment to all WSMHS e-mail addresses (a method use with previous success[13]). E-mail is a fast and cost-efficient survey method, but can introduce new difficulties (e.g. subject identification and redundant addresses)[14 15]. It was estimated that over 90% of the target population were included in this e-mail list.

The questionnaire was delivered to 252 valid e-mail addresses, and non-responders received a reminder at seven days and hard copies at three weeks. Fifty-nine recipients did not spend more than ten hours per week in the two buildings (and were excluded), creating an accessible population of 193 addresses.

Results of the RSH questionnaire are calculated by the mean number of symptoms per respondent (from the list of eight). This is termed the person symptom index, PSI_8, and when averaged across a building, is the building symptom index, BSI_8. The PSI_5 and BSI_5 (from a list of five symptoms), exclude skin symptoms, runny nose and irritated eyes, have a more predictable distribution and can be compared to the BSI_5 of 42 British buildings[3]. The PSI_8 and BSI_8 are more sensitive to small differences, so were used for factor analyses in this study. Occupation was grouped into six categories, involving similar tasks, status and income. Statistical analyses used chi-squared (X^2), the Kruskal-Wallis Test (a non-parametric ANOVA, which produces the statistic H, with a X^2 distribution), Wilcoxon Two-Sample Tests (a non-parametric t-test), and multiple logistic regression models on SAS 8.0 (Cary, NC, USA) and SPSS v10.1 (Chicago, IL, USA) software packages.

Table 1. The Building Symptom Indices of Wellington School of Medicine and Health Sciences

Building (n)	Ventilation system – area (n)	BSI_8	BSI_5
Total (106)		2.45	**1.76**
Academic (69)		2.29	**2.05**
	A (39)	2.03	**1.49**
	B - Library (10)	1.50	**1.00**
	B - Animal facility (2)	5.00	**3.50**
	B - All other areas (18)	3.22	**2.17**
Link (37)	**C** (37)	2.74	**1.71**

RESULTS

From the 193 target e-mail addresses, a total of 114 completed questionnaires were returned (overall 60% response). Only 31% of the respondents were men, and they were significantly older than the women, with higher levels of formal education and more senior academic positions than female respondents. None of the other medical, occupational, psychosocial or environmental factors differed significantly between the genders. There was no information available on non-responders, so it was not possible to assess responder bias objectively.

Overall, respondents reported an average of 2.45 work-related SBS symptoms (from the list of eight, while the BSI_5 was 1.76). Only 27% of respondents did not report any of the eight work-related SBS symptoms, and 57% experienced at least two symptoms (which is described as an important level for effects on productivity[16]).

The BSI for areas of WSMHS are shown in Table 1. The BSI_8 (or BSI_5) did not differ significantly between these five ventilation areas, despite the wide range of symptom rates (Kruskal-Wallis, $H_{(4)} = 8.97$, $p = 0.062$). Logistic regression could not adjust for gender and job position, because respondents from some locations were entirely female, or of one job type. Alternative models, using broader location zones, found no differences in prevalence after adjustment for gender and occupation. The floor, or room type of the occupant were not associated with symptom prevalence either.

Women suffered more symptoms (PSI_8 2.91, PSI_5 2.09) than men (PSI_8 1.35, PSI_5 1.00), as tested by the Wilcoxon Two-Sample Test (PSI_8: $S_{(75, 34)} = 1325$, $p < 0.001$). Unadjusted odds ratios (uOR) indicated that women suffered significantly more lethargy (3.35, 95% CI 1.4–8.1), blocked nose (3.29, 95% CI 1.2–8.9), dry eyes (8.57, 95% CI 2.4–30.5) and irritated eyes (4.47, 95% CI 1.4–14.0).

Job position was also associated with PSI_8 ($H_{(5)} = 24.9$, $p < 0.0001$). Senior academic staff (of whom 68% were men), suffered fewer symptoms (PSI_8 1.09) than library staff (PSI_8 1.63), followed by clerical/secretarial (PSI_8 2.89), research (PSI_8 3.12), managerial (PSI_8 3.33), and technical staff, who suffered most (PSI_8 4.08).

Several other factors were associated with PSI_8 on univariate analysis. An attempt was made to correct for the large number of interacting factors, using sequential logistic regression. The result modelled the odds of suffering each symptom, adjusted for gender, job position, subjective ratings of indoor air quality, air movement, lighting and overall comfort, computer use, photocopying, and history of asthma, rhinitis or conjunctivitis. The adjusted odds ratios (aOR) for gender were not significantly different to 1.0, with the exception of dry eyes, which women were 7.69 times more likely to suffer, after adjusting for other factors, (95% CI 1.80–32.8). Some other symptoms appeared associated with gender (e.g. lethargy aOR 4.15, 95% CI 0.93–18.6; dry throat aOR 0.46, 95% CI 0.11–1.87), but the model did not have sufficient power to detect this.

DISCUSSION

Overall, workers in WSMHS facilities suffered an average of 2.45 work-related SBS symptoms each and 73% of respondents reported at least one. This means the WSMHS facilities were not particularly 'sick buildings' by international standards, and compared favourably to British building with similar ventilation systems[2]. The reported symptom rates were generally lower than were found in Palmerston North buildings, or the UK study (except for women suffering dry eyes)[17]. It would seem then, that WSMHS has SBS symptoms at similar, if not healthier, rates to comparable buildings.

A total of 57% of respondents reported at least two work-related symptoms, a similar

proportion to a Palmerston North study, and the large British study[3 17]. This is reported as the level at which symptoms negatively affect productivity[16], and this result is therefore relevant to building managers at WSMHS.

A possible source of selection bias in this study was the e-mail delivery method, which excluded workers without e-mail. These workers would have different work characteristics (and thus may suffer more or fewer SBS symptoms), but it was not possible to assess these differences accurately. The e-mail method also targeted redundant addresses, and introduced avoidable problems of subject identification and localisation. All of these problems could be corrected in future studies by defining the accessible population with human resources data, and then identifying their e-mail addresses if available. The modest response rate of 53% makes selection bias a greater possibility, and is another limitation of this study. However, the methods used in this study have been shown to have validity and reliability in previous international research [11 12 13].

Within WSMHS, no areas were found to have significantly worse SBS prevalence than others, despite a wide range of values (BSI_5 between 1.0 and 3.5). This suggests that any causative environmental factors were either variable within the large location zones, or were weak compared to the overlying heterogeneity of SBS and personal/occupational factors. The associations between individuals' environmental perceptions and SBS symptom rates might suggest the former.

Gender and occupation (and occupational factors) were interrelated, and were both strongly associated with SBS symptoms. Both of these associations persisted after adjustment for many covariates. It is not known why women suffer more symptoms than men[5 9], but job-related factors are much easier to hypothesise (e.g. level of control over work and environment). However, in this study none of the many occupational or psychosocial factors that were investigated were predictive of symptoms in the multiple regression model.

In summary, SBS symptom rates in WSMHS facilities were found to be comparable to office buildings studied in Britain and New Zealand. Consistent associations between gender, occupation and SBS symptoms explained more of the variation than did workers' location within WSMHS. In buildings where SBS is suspected, detailed investigation is required to provide evidence from which building management decisions can be made.

ACKNOWLEDGEMENTS

We gratefully acknowledge assistance with statistical analysis from Dr Kristin Wickens and Mr Gordon Purdie, WSMHS. Our thanks to the staff of WSMHS that took part. Funds were provided by the Asthma and Respiratory Disorders Research Theme (University of Otago).

REFERENCES

1. Finnegan MJ, Pickering CA, Burge PS.
The sick building syndrome: prevalence studies
Br Med J (Clin Res Ed) 1984;289(6458):1573-5

2. Raw GJ.
A questionnaire for studies of sick building syndrome: A report to The Royal Society of Health Advisory Group on sick building syndrome
Building Research Establishment, 1995

3. Burge S, Hedge A, Wilson S, Bass JH, Robertson A.
Sick building syndrome: a study of 4373 office workers
Ann Occup Hyg 1987; 31(4A): 493-504

4. Menzies D, Bourbeau J.
Building-related illnesses (Review)
N Engl J Med 1997; 337(21): 1524-1531

5. Brasche S, Bullinger M, Morfeld M, Gebhardt HJ, Bischof W.
Why do women suffer from sick building syndrome more often than men? Subjective higher sensitivity versus objective causes
Indoor Air 2001;11(4): 217-22

6. Bourbeau J, Brisson C, Allaire S.
Prevalence of the sick building syndrome symptoms in office workers before and after being exposed to a building with an improved ventilation system
Occup Environ Med 1996; 53(3): 204-10

7. Hodgson MJ, Collopy P.
Symptoms and the micro-environment in the sick building syndrome: a pilot study.
In: Engineers ASoHRaAC, editor
IAQ 89 - The Human Equation: Health and Comfort
Atlanta: American Society of Heating Refrigerating and Air Conditioning Engineers 1989: 8-16

8. Mendell MJ, Smith AH.
Consistent patterns of elevated symptoms in air-conditioned office buildings: a reanalysis of epidemiologic studies
Am J Pub Health 1990; 80(10): 1193-1199

9. Stenberg B, Wall S.
Why do women report 'sick building symptoms' more often than men?
Soc Sci Med 1995;40(4):491-502

10. Bickerstaff M, Blunt A, Carter K, Harvey P, Jamison M, King A, *et al.*
Is this school a sick building?
Wellington: Department of Public Health, Wellington School of Medicine, 1994

11. Burge PS, Robertson AS, Hedge A.
Comparison of self-administered questionnaire with physician diagnosis in the diagnosis of the sick building syndrome
Indoor Air 1991;4: 422-427

12. Burge PS, Robertson AS, Hedge A.
The development of a questionnaire suitable for the surveillance of office buildings to assess the building symptom index, a measure of the sick building syndrome
In: Jaakkola JJK, Ilmarien R, Seppanen O, editors
Indoor Air '93 - Proceedings of the Sixth International Conference on Indoor AIr Quality and Climate
Helsinki, 1993: 729-736

13. Hannah ML.
Health Risk Perceptions of Environmental Hazards [Master]
University of Otago, 2001

14. Sheehan KB, Hoy MG.
Using e-mail to survey internet users in the United States: Methodology and assessment
Journal of Computer Mediated Communication 1999;4(3):1-21

15. Weible R, Wallace J.
Cyber research: The impact of the internet on data collection
Marketing Research 1998;10(3):19-24

16. Raw GJ, Roys MS, Leaman A.
Further findings from the office environment survey: productivity
In: Walkinshaw DJ, editor.
Indoor Air '90 - Proceedings of the Fifth International Conference on Indoor Air Quality and Climate
Toronto: Canadian Mortgage and Housing Commission, 1990:231-236

17. Phipps RA, Sisk W, Wall G.
A comparison of two studies reporting the prevalence of sick building syndrome in New Zealand and England
NZ Med J 1999;112:228-230