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SICK BUILDING SYNDROME IN THE GENERAL SWEDISH POPULATION -THE SIGNIFICANCE OF OUTDOOR AND INDOOR AIR QUALITY AND SEASONAL VARIATION

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ABSTRACT

The sick building syndrome (SBS) is concerned with eye, skin, upper airway symptoms, headache and fatigue. Possible relations between such symptoms, seasonal variations and environmental exposures were studied in a random sample of 1000 adult Swedes. The response rate was 70%. SBS-symptoms were common in the population, and eye symptoms were most prevalent during the summer. Childhood exposure to environmental tobacco smoke was related to both hayfever, nickel allergy and SBS. A childhood near a mining industry was also related to allergies and SBS. Current exposure to new dwellings and damp or mouldy buildings were also related to SBS, and the season acted as an effect modifier on the health effect of building dampness. It was concluded that SBS-symptoms are common in the general population and related to certain childhood exposures and current indoor exposures such as damp or mouldy buildings.

INTRODUCTION

The sick building syndrome (SBS) is concerned with various nonspecific symptoms such as eye, skin, and upper airway irritation, headache and fatigue[1]. During recent years, several epidemiological investigations on such symptoms have been published[2-10]. Various factors, such as indoor concentration of volatile organic hydrocarbons[2-4], presence of wall-to-wall carpets or fleecy material[2,8], age of the building[6], type of ventilation system[5,8], passive smoking[2], moulds[10], and building moisture[9-10] have been shown to influence the prevalence of SBS-symptoms. In addition, such symptoms are also influenced by personal factors[2,4,7], industrial exposure to irritants[2], residential factors[2,4,9] and childhood exposures[2].

This study was performed to study relationships between environmental exposures and the prevalence of SBS-symptoms. The main aim was to investigate to what extent relationships shown in earlier studies among office workers or young children could be confirmed in the adult Swedish population. The second aim was to study seasonal variations of the prevalence of symptoms, and possible interactions between the season and the effect of the exposure.

METHODS

In a random sample (1000 subjects or 0.008%) of the general population aged 20-65 in Sweden, possible relations between three month prevalence of symptoms and environmental,

occupational, and personal factors were studied. Information on age and gender was obtained from the civil registration register.In order to study the influence of seasonal variations of symptoms, the material was divided into four subsamples (250 subjects in each). The subjects in each subsample were requested to answer a standardized self administered questionnaire[4] during one of the four seasons.

Symptoms were recorded by a self-administered questionnaire, requesting information on personal factors such as education level, smoking habits, atopy, contact allergy, hyperreactivity, sick leave, work stress, work satisfaction, and climate of cooperation at work. It also contained questions requiring "yes" or "no" answers on 16 different symptoms and covered the previous three months. The symptoms were classified as either eye, airway, dermal or general symptom and the prevalence of subjects with at least one symptom in each group were calculated. Work stress, work satisfaction, and climate of cooperation were measured with an analogue rating scale used in earlier studies[2]. The questionnaire also gathered information on the current dwelling such as building age, size of the dwelling, type of ventilation system, presence of wall-to-wall carpets, recent renovation, presence of house-pets, moisture damage, and signs of mould growth. Finally, it required information on environmental exposures during the subject's childhood (0-5 years age). These questions covered parental smoking, industrial pollution exposure, and child care outside the home.

The influence of different factors on the prevalence of symptoms was analysed by logistic regression and chi-square statistics for two * two contingency tables, using two tailed tests and a 5% level of significance.

RESULTS

The over all response rate was 70%. Both eye, airway, dermal and general symptoms were common in the population, and there were only minor seasonal variations of the prevalence of SBS-symptoms, **table 1**. Eye symptoms, however, were significantly more prevalent during the summer ($p<0.05$). For other symptoms, however, no statistically significant influence of the season on the prevalence of symptoms could be shown.

Common allergies and the psychosocial work climate had a strong and highly significant influence on the prevalence of SBS-symptoms ($p<0.01$). The prevalence of allergies in the adult population was in turn influenced by different childhood exposures. Childhood exposure to environmental tobacco smoke from smoking mothers was related to a higher prevalence of both hayfever ($p<0.05$) and nickel allergy ($p<0.05$) in the adult population. Childhood exposure to environmental tobacco smoke from smoking fathers was related to a higher prevalence of general symptoms (($p<0.01$). Frequent otitis media during childhood was related to an increased prevalence of both hayfever ($p<0.05$), nickel allergy ($p<0.05$), airway symptoms ($p<0.01$) and dermal symptoms ($p<0.05$) in the adult. In addition, a childhood near a mining industry was related to both hayfever ($p<0.01$), allergy to furry animals ($p<0.001$) and eye symptoms ($p<0.05$).

Table 1. Seasonal variation of SBS-symptoms. Three month prevalence of symptoms during different seasons in a random sample of the general Swedish population (N=695).

Type of symptom	3-months prevalence (%) autumn (N=180)	winter (N=172)	spring (N=171)	summer (N=172)
Eye irritation	18	15	14	24
Swollen eyelids	8	8	7	15
Nasal catarrh	12	13	13	14
Blocked-up nose	23	23	20	27
Dryness in the throat	19	15	20	19
Sore throat	9	10	9	7
Irritative cough	6	10	7	13
Headache	23	20	18	24
Abnormal tiredness	38	30	32	28
Sensation of getting a cold	26	27	23	23
Nausea	9	5	5	5
Facial itching	7	9	7	10
Facial rash	7	7	9	10
Itching on the hands	7	9	10	8
Rashes on the hands	11	8	9	9
Eczema	12	14	11	15

For current indoor exposures, building age and building dampness was significantly related to SBS-symptoms. Subjects living in new buildings reported a higher prevalence of dermal symptoms ($p<0.05$). In addition, building moisture or microbial growth in the dwelling and the workplace building was significantly related to various types of SBS-symptoms, **table 2**.

Table 2. Odds ratios for damp or mouldy buildings and various types of symptoms in the general population (N=695).

Type of building	Type of symptom Eye	Airway	Dermal	General
Damp or mouldy dwelling#	1.8*	2.0*	2.1*	2.7*
Damp or mouldy workplace building#	1.6	2.0*	1.5	2.3*

*Odds ratio significantly greater than one

#The inhabitant should have observed at least one of the following 4 signs in the dwelling during the last 12 months:

1.Water damage or flooding

2.Blackened parquet floor or bubbles under PVC-floor

3.Visible moulds on exposed surfaces

4.Mouldy odour

A modifying effect of the season cold also be shown for this type of exposure, particularly for damp or mouldy workplaces. The relation between damp and mouldy buildings and airway symptoms were strongest during the winter, and the relation to general symptoms were most pronounced during both winter and summer, **table 3**.

Table 3. The modifying effect of seasonal variations on the relation between damp or moldy work-place buildings and symptoms (OR= Odds ratio).

	Type of symptom	
	Airway	General
Season	OR	OR
Winter (December-February)	3.5*	4.9*
Spring (March-May)	1.5	2.3
Summer (June-August)	2.3	3.0*
Autumn (September-November)	1.4	1.1

*Odds ratio significantly greater than one

No relation was found between SBS-symptoms and air humidification, types of ventilation system, house pets, wall-to-wall carpets, or annoyance by environmental tobacco smoke. A borderline significance was found for eye irritation and newly painted surfaces either at home or at work (p=0.05).

DISCUSSION

Symptoms of the type comprised in the definition of SBS are common in the general population and related to both personal, occupational and environmental factors such as childhood exposure to tobacco smoke, certain outdoor pollutants, building age and damp or mouldy buildings. The results from this study confirm many findings in an earlier study performed in a random sample the general population in mid-Sweden[4].

The finding that dermal symptoms were more common in new buildings agrees with other studies on the SBS-syndrome. A relationship between SBS-symptoms and new buildings has earlier been demonstrated in the Town Hall Study[6]. It has also been shown that moving from old to new dwellings resulted in an increase in SBS-symptoms[2]. In addition, most of the problem buildings ("sick buildings") are new buildings, built during the two latest decades[11]. It is well known that there is a decay of the emission of volatile chemicals from building materials over time, and the highest chemical exposure is found in new buildings. In addition, building technology has changed over time and more sophisticated ventilation systems and new building materials have been introduced during the last decades. Thus, an inverse relationship between building age and the prevalence of SBS-symptoms could be expected.

Signs of building moisture or microbial growth in both dwellings and workplaces was related to various types of SBS-symptoms. The relation between SBS-symptoms and damp and

mouldy buildings agrees with earlier investigations. In a population study in mid-Sweden performed during springtime, damp or mouldy houses were significantly related to fatigue, headache, and dermal symptoms[10]. Similar results were obtained in a Danish study, where building moisture or moulds at home was related to a higher prevalence of headache or mucosal irritation[9]. In a Swedish survey, 50% of the problem buildings ("sick buildings") known by occupational health care centres were affected by either mould growth or water damage[11]. In a study of Dutch dwellings, a higher prevalence of respiratory symptoms was found among children or females living in damp houses in comparison with those living in dry homes[12]. A relation between SBS-symptoms and dwellings with moist casein-containing self-leveling mortal has also been proved[13]. It was also shown that removal of such contaminated mortal resulted in a decrease of SBS-symptoms[13].

It has been suggested that sensory stimulation of the olfactory or trigeminal nerves plays a role in the development of SBS-symptoms, but there are probably also other mechanisms in certain mouldy buildings with more severe health problems. To obtain a better understanding of the health effects of damp or mouldy buildings, more detailed epidemiological studies should be performed. In such studies, other exposure indicators than signs of dampness or moulds should be applied. Such indicators could be presence of house dust mites in settled bedroom dust[10], the airborne concentration of particular mould species such as *Aspergillus versicolor*[10], microbial volatile organic compounds (MVOC)[14] or inflammatory compounds such as endotoxines or glucanes[15].

Besides for eye irritation, there were no significant seasonal variations of the prevalence of symptoms. For damp or mouldy buildings, however, the season seems to act as a strong effect modifier on the occurrence relation for SBS-symptoms. The role of seasonal variations as effect modifier for indoor exposures and SBS-symptoms is, to our knowledge, a new finding. Since few investigators seems to have considered the influence of seasonal variations and controlled for it, this could be one explanation of why contradictory results are sometimes published on the effect of particular indoor exposures on the sick building syndrome.

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