

Short Communication

Sick Building Syndrome in an Office Building Formerly Used by a Pharmaceutical Company: A Case Study

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Abstract In the past two decades, a group of health problems related to the indoor environment – generally termed sick building syndrome (SBS) – has emerged. We present an investigation of SBS in employees of a ministry working in a naturally ventilated office building that formerly had been used by a pharmaceutical company. A preceding environmental monitoring had failed to identify the cause(s) for the complaints. We conducted a questionnaire-based investigation and categorized the building sections and rooms according to their renovation status and their former use, respectively. The highest level of complaints was found among the employees working in rooms that in the past had been used for the production or storage of various pharmaceutical products suggesting that pharmaceutical odors may be a risk factor for SBS. Clinical laboratory tests did not show any unusual results. We conclude that the former use of a building for production and storage of pharmaceutical products should be considered as a possible risk factor for complaints about indoor air quality, e.g., when advising about or planning for renovations of buildings formerly used for production, handling, or storing of chemicals.

Key words Occupational diseases etiology; Indoor air pollution; Odors; Renovation; Sick building syndrome.

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ical picture, objective abnormalities on clinical or laboratory evaluation, and one or more identifiable sources or agents known to cause infectious, immunologic, or allergic diseases such as legionnaire's disease, hypersensitivity pneumonitis, or work related asthma. In contrast, the term "sick building syndrome" (SBS) refers to a heterogeneous group of non-specific vegetative and central nervous symptoms (e.g., headaches, fatigue, lack of concentration), symptoms of the mucous membranes and the skin (e.g., irritation or dryness), which usually disappear soon after the affected person leaves the building (Menzies and Bourbeau, 1997; Redlich et al., 1997). Some authors recommend to avoid the use of the term SBS in favor of a simpler, descriptive diagnosis or a different diagnostic label, e.g., "idiopathic building intolerance" (Bardana, 1997) or "non-specific building related illness" (Menzies and Bourbeau, 1997); however, no consensus has been reached yet. The SBS generally has a multifactorial etiology, including chemical, physical, biological and psychological risk factors (Molina et al., 1989; Seifert, 1991). In this case report, we present the results of an investigation of SBS in a naturally ventilated office building formerly used by a pharmaceutical company.

Introduction

In the past two decades, the public and scientific community have become increasingly aware of indoor air quality and its effects on human health (Molhave, 1987; Seifert, 1991; WHO, 1982). Specific building-related illnesses are characterized by a fairly homogeneous clin-

Background and Objectives

The Building

The building was erected in the early 1960s on a main road in Bonn, Germany, and consists of three naturally ventilated sections. Until the mid-1980s, the entire building was used by a pharmaceutical company pre-

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dominantly for administration purposes. Only some of the rooms in section I and section II had served as production and storage sites for pharmaceutical products. Consecutively, the Federal Government rented sections II and III for office use. In February 1992, after one year of renovation, additional divisions of a ministry moved into section I.

Environmental Monitoring

As early as 1990, several employees had complained about headaches and unpleasant odors in section II. In two of the rooms, building material that was saturated with derivatives of peppermint oil was identified as the most likely source of the unpleasant odors. The presence of these compounds was attributed to the former use of these rooms as dry rooms for pharmaceutical products. The rooms were excluded from further use.

Starting in February 1992, employees in section I complained about unpleasant odors and a variety of non-specific work-related symptoms. In May 1992, an environmental laboratory examined ambient air in selected rooms for formaldehyde, diisocyanates, phthalates, amines, and several volatile organic compounds (VOC). None of these chemicals were found at elevated levels. Also, the climatic parameters in the offices were normal. Olfactometric investigations of the new carpet (section I) in a test chamber did not show any unusual results. These environmental investigations, which did not yield evidence for causes of specific building-related illnesses, were done by other investigators and are not part of this paper.

Further Course of Action

Since the (untargeted) environmental investigations failed to identify the causes of the complaints, we were asked to further investigate the problem. In a first step, to assess the type and extent of the complaints and to identify areas with an increased prevalence of work-related complaints, the employees in all three sections were interviewed in August 1992. In addition, at the request of the ministry, blood testing for signs of organ dysfunction was offered to the employees who were concerned about adverse health effects.

Materials and Methods

Questionnaire

For the purpose of our investigation, we adapted the standardized questionnaire that had been used by Kröling (1985). The key element of the questionnaire is the statement "while at work, I am suffering from the following noticeable impairments of my well-being" fol-

lowed by a panel of eleven different complaint parameters (categorized as "strong", "moderate", "scarce" and "not at all") to which we added ten more parameters. For our analysis, the assessments "moderate" and "strong" were combined. Additional questions deal with job activities, furnishing of the workplace, and with the state of well-being at the time of the interview. In addition, all employees were asked about previous and accompanying illnesses, current complaints as well as drug, tea, coffee, alcohol and tobacco consumption.

During a staff meeting, the purpose of the investigation was discussed with the employees who then were asked to anonymously complete a written questionnaire. In the following, the term "complaints" will be used to indicate medical as well as general complaints.

Laboratory Investigation

The blood tests included the following parameters: red and differential white blood cell count, lymphocyte subpopulations (CD3, CD4, CD8 and CD19), immunoglobulins (IgG, IgA, IgM and total IgE), alanine aminotransferase, aspartate aminotransferase, gamma-glutamyltransferase, creatinine, urea nitrogen, triiodothyronine, thyroxine and basal thyroid stimulating hormone.

Evaluation Strategy

The structure of the available data permitted us to compare:

- the prevalence of complaints among the employees according to the renovation status, i.e., section I (renovation) versus sections II and III (no renovation each); and
- the prevalence of complaints among the employees according to the utilization, i.e., sections/rooms that were formerly used as production and storage sites for pharmaceutical products (some areas in sections I and II) versus the other areas.

In addition, the prevalence of complaints in the above subgroups was compared with prevalence data from Kröling's study (office staff and civil servants in public administration working in naturally ventilated buildings; $n=508$). We used Fisher's exact test to compare expected with observed proportions.

Results

Study Population

A total of 140 (72%) of 194 employees returned a questionnaire (Table 1). For 94 (67%) of the 140 questionnaires we had complete data; however, the avail-

Table 1 Study population and characteristics of the study cohort

Finding ^a	section I	section II	section III	total
Response rate	71/95 (75%)	42/56 (75%)	27/43 (63%)	140/194 (72%)
Fully completed questionnaire ^b	46/71 (65%)	28/42 (67%)	20/27 (74%)	94/140 (67%)
Mean age (range) in years	39 (22-57)	40 (23-54)	40 (25-60)	40 (22-60)
Female sex	24/46 (52%)	10/28 (36%)	6/20 (30%)	40/94 (43%)
Smoking	13/46 (28%)	7/28 (25%)	4/20 (20%)	24/94 (26%)
Passive smoking	3/46 (7%)	2/28 (7%)	1/20 (5%)	6/94 (6%)
Asthma	3/46 (7%)	3/28 (11%)	0/20 (0%)	6/94 (6%)
Hay fever	8/46 (17%)	7/28 (25%)	2/20 (10%)	17/94 (18%)
Eczema	7/46 (15%)	5/28 (18%)	3/20 (15%)	15/94 (16%)

^a Absolute numbers and (%) unless otherwise stated

^b For comparison with the reference group from Kröling's Study (1985), only fully completed questionnaires were used

able data of the 46 excluded, incomplete questionnaires did not differ from these 94 questionnaires. The response rate, as well as demographic and other variables did not differ significantly between the three sections.

Evaluation According to the Utilization

The prevalence of complaints among the employees working in rooms that had been used for the production and storage of pharmaceutical products was higher compared with that of the employees from the other rooms ($P < 0.05$; Fig. 1). Eye irritation, headaches and unpleasant odors were reported by approximately half of these employees. There were no significant differences in regard to the general characteristics (i.e., sex, smoking, atopy, etc.) of the two subgroups (data not shown).

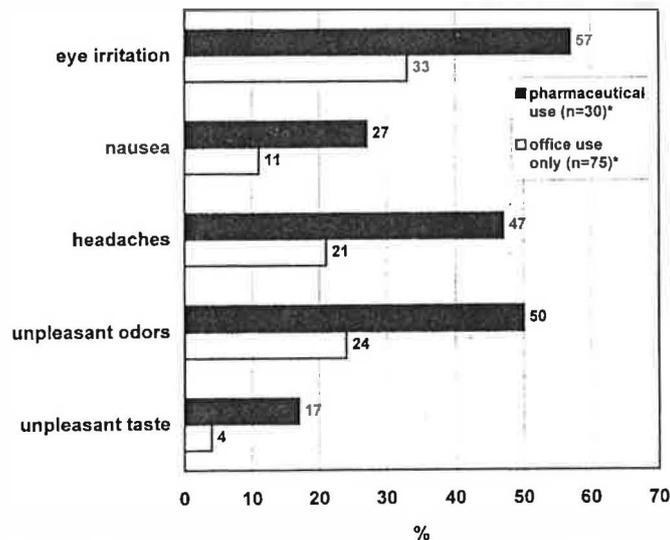


Fig. 1 Complaint parameters showing significant differences ($P < 0.05$) between rooms with former production and storage of pharmaceutical products compared with rooms exclusively used as offices (*Total number of questionnaires completed by persons from rooms for which the former use was known)

Evaluation According to the Renovation Status

In general, the prevalence of complaints was higher in section I (renovation) than in section III (no renovation) (Table 2). Eye irritation, nasal symptoms, headaches and dry mucous membranes were reported by more than 40% of the employees working in section I, compared with 15-20% in section III. Section II (no renovation) showed an intermediate level of complaints; however, unpleasant odors and dry mucous membranes were reported equally by about 40% of the employees working in sections I and II.

Comparison with the Data from Kröling's Study

When compared with the data from Kröling's study, the employees in section I complained more often about headaches and lack of energy (Table 2). In contrast to this, the level of complaints among the employees in section III was generally lower (tendency) than in the reference group from Kröling's study. Section II showed no uniform pattern. Susceptibility to colds was reported more often in the reference group from Kröling's study than in sections I, II and III.

Laboratory Investigation

Blood specimens were tested for 120 persons. The proportion of pathologic results among these persons was below that expected among the general working population. Among the subgroups, no differences were observed.

Discussion

In our investigation, working in rooms formerly used for the production and storage of pharmaceutical products was associated with a higher level of non-specific complaints indicating that pharmaceutical odors may be a risk factor for SBS. The fact that laboratory tests did not show any concomitant biologic effects corresponds well with the experience of other authors on

Table 2 Prevalence (%) of work-related complaints in sections I, II and III and in the reference group from Kröling's study (1985)

Complaint parameter	Section I ^a (n=46)	Section II ^b (n=28)	Section III ^c (n=20)	Kröling (K) ^c (n=508)	P value
Lack of concentration	20	7	20	25	0.031 (II/K)
Fatigue	33	21	20	24	
Dizziness	9	4	5	7	
Irritability	24	14	10	21	
Lack of energy	26	25	15	15	0.048 (I/K)
Headaches	44	25	15	26	0.011 (I/K)
Rheumatic complaints	9	4	10	16	0.026 (I/III)
Susceptibility to colds	22	7	10	39	0.021 (I/K)
					0.001 (II/K)
					0.009 (III/K)
Hypotensive symptoms	13	18	15	22	
Heavy tired legs	13	14	30	15	
Dry mucous membranes	44	39	20	31	
Eye irritation	44	32	20	n.d.	
Nasal symptoms ^d	46	21	15	n.d.	0.017 (I/III)
Hoarse, dry throat	33	18	20	n.d.	
Cough	13	0	10	n.d.	
Dry facial skin, rash	22	14	10	n.d.	
Itching, dry hands	20	7	0	n.d.	0.033 (I/III)
Itching scalp	11	14	5	n.d.	
Unpleasant odors	39	43	10	n.d.	0.018 (I/III)
					0.014 (II/III)
Unpleasant taste	15	4	5	n.d.	
Nausea	17	14	10	n.d.	

^a renovation, former pharmaceutical use (i.e., storage/production of pharmaceutical products in some areas)

^b no renovation, former pharmaceutical use

^c no renovation, no former pharmaceutical use

^d irritated, congested or running nose

n.d. - no data from Kröling's study

SBS (Apter et al., 1994; Hodgson and Storey, 1994; Maroni and Levy, 1992).

Psychological and cognitive factors, e.g., beliefs about risk, may modulate the perception of environmental influences and expression of complaints (Bachmann and Myers, 1995; Chandrakumar et al., 1994; Dalton, 1996). Thus, our discussion with the employees about the purpose of the investigation may have influenced the level of awareness for the problem. However, this potential information bias is an unlikely explanation for the spatial distribution of complaints in our study, because the former use of the particular rooms was not known to those interviewed.

Previous renovation also was associated with a higher level of SBS-complaints but did not explain the high prevalence of complaints, i.e., unpleasant odors and irritation of mucous membranes, in section II. Although differences in sex, smoking and atopy status did not reach statistical significance, the higher proportion of women in section I may have led to an overestimation of the effect of renovation. This corresponds to the findings in other studies, where the prevalence of SBS-complaints was higher among women than among men (e.g., Bachmann and Myers, 1995; Stenberg and Wall, 1995).

The prevalence of complaints in section III (i.e., no

renovation and no previous use for storage or production of pharmaceutical products) was comparable to the prevalence in "non-complaint" buildings, which is generally between 10% and 30% (Finnegan and Pickering, 1987; Mendell and Smith, 1990; Seifert, 1991; Skov and Valbjorn, 1987). In a meta-analysis, Mendell and Smith (1990) showed that even higher prevalences of complaints in "non-complaint" buildings are due to a very broad definition of "work-related complaints", emphasizing the need for a standardized approach. Bullinger (1992) notes that most of the instruments available for the investigation of SBS lack a sound conceptual basis. This may explain to some extent the lack of clearly identifiable components and causes of SBS to date (Chang et al., 1993).

When data from other studies are used for comparisons, some limitations must be considered carefully. For example, Kröling's study was conducted during the winter. This fact may explain why the susceptibility to colds was higher among the persons in his reference group than among the employees in our investigation, which was conducted during the summer. In addition, Kröling's report does not contain detailed information about possible confounders, limiting its value for comparisons with other data. However, until better data are available, such data are useful as a reference for an

initial assessment of the results of investigations like ours.

We conclude that the former use of a building for production and storage of pharmaceutical products should be considered as a possible risk factor for complaints about indoor air quality, e.g., when advising about or planning for renovations of buildings formerly used for these purposes. Further research is needed to better understand the effects of the modern office environment on our health.

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