THE DANISH TOWN HALL STUDY - A ONE-YEAR FOLLOW-UP

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In a one-year follow-up in four of the buildings included in the Danish town hall study the influence of the indoor climate on the sick building syndrome has been investigated. A questionnaire was sent to all of the employees (1018 persons) and extensive measurements of the indoor climate were carried out in 36 office rooms in the four buildings.

The results of the measurements of the indoor climate were in accordance with the results of the first part of the study.

Multivariate logistic regression analyses of the influence of the indoor climate factors on the prevalence of work-related mucosal irritation and work-related general symptoms among the 215 office workers in the 36 office rooms showed that temperature, relative humidity, and the quality of the cleaning were associated with the prevalence of the symptoms.

INTRODUCTION

The sick building syndrome is characterized by irritative symptoms of the eyes, nose, and throat; dryness and irritation of the skin; headache; tiredness; and lethargy. The symptoms are experienced as work-related as they typically grow worse during the workday in the building and disappear or diminish when the workers leave the building. The sick building syndrome has been associated with the type of ventilation system - especially air-condition, carpets, open-spaced offices, age of the building, floor dust, and two easily recognizable factors: the shelf factor and the fleece factor (1). A major methodological problem in these epidemiologic studies is how representative the measurements are of the indoor climate in the whole building and throughout the year. Some aspects of this methodological problem have been taken up in the second part of the Danish town hall study where a selected sample of buildings has been studied one year after the first part of the study was carried out. This paper describes the association between the measurements of the indoor climate in the offices and the occurrence of work-related mucosal irritation and work-related general symptoms.

MATERIALS AND METHODS

The buildings

Four buildings with different prevalences of mucosal irritation and general symptoms were selected among the buildings studied in the first part of the Danish town hall study.

The age of the buildings ranged from 9 to 48 years. One building was situated in a rural area and three in residential areas. All four buildings had central mechanical ventilation systems; one building only had an exhaust air system while three had both supply and exhaust air systems and one of these had humidifiers. All buildings had windows which could be opened and radiator or convector heating.

Study population

855 of the 1018 employees filled in and returned a short question-naire with questions on complaints about the indoor climate, the presence of work-related symptoms from the mucous membranes, and the presence of general symptoms and skin symptoms.

Indoor climate measurements

Eight to ten offices were selected in each building, a total of 36 offices. Measurements of airborne dust, air temperature and humidity, carbon dioxide, ozone, static electricity, fleece factor and shelf factor, floor area, volume of the office and number of occupants of the office were carried out in all 36 offices together with a semiquantitative estimation of the quality of cleaning according to cleaning methods, materials, frequency, and ability of carrying through the cleaning. In eight of the offices measurements of microorganisms, volatile organic vapors, airborne and settled fibres, floor dust, carbon dioxide, noise and time of reverberation, positive and negative ions, lighting, ventilation rate, odour and air quality were also made. The measurements were performed on 12 consecutive days in each building during the period from January to March 1985 and have previously been described in detail (2).

Statistical methods

The multifactorial effects of the indoor climate factors on the prevalences were analyzed in a logistic regression model adjusted for the effect of gender. Due to the large number of indoor climate factors investigated and the limited sample of persons (215 employees) in the offices where measurements were made, the estimation was carried out with a modified backward elimination procedure. The level of significance used in the analyses was $P < 0.05$.

RESULTS AND DISCUSSION

The results of some of the essential indoor climate measurements are shown in table 1. The values are mainly at levels normally considered acceptable and in accordance with the ones previously reported (3).

Table 1 Indoor climate measurements[a]

		Mean	Min.	Max.
Air temperature	(°C)	22.5	19.9	24.3
Temperature rise during the day	(°C)	2.1	1.1	3.1
Relative humidity	(%)	33	25	40
Airborne dust	(mg/m³)	0.22	0.09	0.95
Ozone	(ppm)	<0.0004	<0.0001	<0.0004
Formaldehyde	(mg/m³)	0.08	0.04	0.13
Volatile organic compounds	(mg/m³)	0.59	0.07	3.19
Carbon dioxide	(%)	0.08	0.04	0.13
Macromolecular organic dust	(mg/g)	3.1	0.1	6.2
Ventilation rate per workplace	(1/s)	8.3	4.7	13.3

[a] A selected sample of the 28 different indoor climate factors
which were measured.

Table 2 Odds ratio for mucosal irritation.

		$\hat{O}R$	95% CI
Gender:	Male	1	
	Female	2.10	1.06-4.17
Quality of cleaning:	"good"	1	
	"not so good"	3.11	1.59-6.11
	"bad"	1.44	0.42-4.92

Multivariate logistic regression analyses of 157-215 office workers
in offices, where measurements of the indoor climate were made.

$\hat{O}R$ = odds ratio
95% CI = 95% confidence interval

Table 2 shows the results of the analyses of the effects of the indoor climate factors on the prevalence of mucosal irritation. The quality of cleaning was significantly associated with mucosal irritation together with gender. The quality of cleaning was categorized as "very good," "good," "not so good," or "bad." However, no office in this study was categorized as "very good".

Office workers staying in offices with a "bad" og "not so good" quality of cleaning had a higher risk ($\hat{O}R$) of mucosal irritation. There were only a few office workers (13 persons) in offices with a "bad" quality of cleaning and the estimate for this category is therefore uncertain.

Table 3 Odds ratio for general symptoms.

		$\hat{O}R$	95% CI
Gender:	Male	1	
	Female	2.92	1.33-6.42
Temperature rise during workday	per 1°C	1.75	1.10-2.77
Relative humidity	per 10°C	2.04	1.05-3.97

Multivariate logistic regression analyses of 157-215 office workers in offices, where measurements of the indoor climate were made.

$\hat{O}R$ = odds ratio
95% CI   = 95% confidence interval

From table 3 it appears that a high daily rise in temperature in the office was together with relative humidity and gender associated with general symptoms. A rise in temperature of eg 3°C in the office during a workday increased the risk of general symptoms among the office workers by three ($\hat{O}R$ = 3.06).

The highest relative humidity was found in the building with humidification of the supply air. The relative humidity in the other buildings was closely associated with the relative outdoor humidity and outdoor air temperature, indicating that this finding may be casual.

CONCLUSION AND RECOMMENDATIONS

The results of this study showed that poor ability of cleaning the office, daily rise in temperature in the office, and maybe humidification of the supply air are important factors associated with the occurrence of the sick building syndrome. It is therefore recommended to use materials which are easy to clean, to organize the office in a way which facilitates the cleaning, and to keep the temperature near 21°C.

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