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This article in PubMed: www.ncbi.nlm.nih.gov/pubmed/2772583
Influence of personal characteristics, job-related factors and psychosocial factors on the sick building syndrome

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SKOV P, VALBJ0RN O, PEDERSEN BV, THE DANISH INDOOR CLIMATE STUDY GROUP. Influence of personal characteristics, job-related factors and psychosocial factors on the sick building syndrome. Scand J Work Environ Health 1989;15:286—295. The influence of personal characteristics, life-style, job-related factors, and psychosocial work factors on symptoms of the sick building syndrome was investigated in Greater Copenhagen, Denmark. The buildings were not characterized beforehand as "sick" or "healthy." Of the 4369 employees sent a questionnaire, 3507 returned them. Multivariate logistic regression analyses of the multifactorial effects on the prevalence of work-related mucosal irritation and work-related general symptoms among the office workers showed that sex, job category, work functions (handling of carbonless paper, photocopying, work at video display terminals), psychosocial factors of work (dissatisfaction with superiors or colleagues and quantity of work inhibiting job satisfaction) were associated with work-related mucosal irritation and work-related general symptoms, but these factors could not account for the differences between the buildings as to the prevalence of the symptoms. The building factor (ie, the indoor climate) was strongly associated with the prevalence of the symptoms.

Key terms: general symptoms, mucosal irritation, office workers, prevalence.

An increasing number of complaints about discomfort and health effects in relation to time spent in residences and nonindustrial workplaces has been reported during the last 10 to 15 years. In 1983 the World Health Organization defined the concept of the sick building syndrome (1) as being characterized by an increased frequency of a number of irritative symptoms of the eyes, nose, throat, and lower airways; skin reactions; nonspecific hypersensitivity; mental fatigue; headache; and nausea and dizziness among persons staying in the building in question. Typically, the symptoms grow worse during the workday in the building and disappear or diminish after the workers leave the building. They are thus experienced as work-related. The etiology of this syndrome is currently not fully understood.

Various factors, some chemical (2), physical (3), biological (4), and psychosocial (5), have been related to the syndrome. The relative importance of these factors for the sick building syndrome has been investigated very little thus far. In addition the epidemiology of the sick building syndrome has only been analyzed in a few studies (6—10). Complaints about work-related irritation of the mucous membranes and work-related general symptoms, such as headache, fatigue, and malaise, have been found to be prevalent, and they differed significantly from one building to another without being explainable by the results of a determination of several components of indoor pollution (7—9). However no analysis has been made of the influence of potential confounders such as work functions, psychosocial factors, and life-style.

The purpose of our Danish town hall study was to examine the influence of various indoor climate factors on the prevalence of the symptoms of the sick building syndrome. The study included a large population, many different buildings, and measurements of many indoor climate factors. We have previously reported that sex, job category, photocopying, work at video display terminals, and the handling of carbonless paper were significantly associated with work-related mucosal irritation and work-related general symptoms, such as headache, fatigue, and malaise (11). In this paper we have further analyzed these associations, together with the possibility of additional associations with certain personal characteristics and psychosocial factors, and have considered whether these factors can account for the differences between the prevalence of symptoms among the office workers in the buildings studied.
Materials and methods

The buildings

Participation in the study was requested of the municipalities of Copenhagen, Frederiksberg, and the County of Copenhagen, the total being 20 municipalities. Thirteen of them entered the study, three were excluded because comprehensive indoor climate studies had been recently carried out or were in progress, one answered too late for it to be included, and three did not want to participate. The town hall in each municipality was selected as the study buildings. In one municipality two buildings (number 120 and 121) were included. Three of the study buildings had minor building construction differences (eg, type of ventilation) and were therefore divided into two parts on the basis of these differences in the multivariate analysis. Among the 14 buildings affiliated with the town halls, two had a population of office workers (168 and 110 for buildings number 61 and 131, respectively) of a size suitable for them to be incorporated into the multivariate analysis, giving a total of 19 buildings in the analysis. The age of the buildings ranged from 1 to 80 (mean 18.8) years. Six buildings were situated in rural areas, six in urban communities, and seven in residential areas. Seven buildings had natural ventilation, and 12 had mechanical ventilation. Of these 12, eight had air intake and four only air exhaust. Of the eight buildings with air intake, two systems provided recirculation and two had humidifiers, of which, however, only one was in use. The floor area ranged from 1250 to 12 900 (mean 4418) m², and the number of employees in the buildings ranged from 84 to 419 (mean 205). The measurements of the indoor climate have already been described previously (11). The many indoor climate factors determined resulted in values mainly at the level normally considered acceptable or in values in accordance with levels previously reported.

Study population

The study population of 4369 employees from the town halls, the 14 affiliated buildings, and various smaller buildings and rooms (with 47 employees only) were sent a questionnaire. Of these persons, 3507 (2347 women, 1115 men and 45 for whom sex was not stated) returned the questionnaire; 3181 of these were office workers. The other employees worked as nurses, town hall officers, or chauffeurs or had jobs in other nonoffice or unknown job categories. The response ranged between 61 and 93 (mean 80) % for the town halls and between 57 and 100 (mean 79) % for the 14 affiliated buildings. The reasons stated for not participating in the study were sick leave, maternity leave, vacation, and, in about 10 % of the cases, unwillingness to participate. The distribution of participants by sex, age, length of time in office work, and job category is given in table 1.

This analysis deals only with the office workers. The multivariate analysis comprised 2829 office workers from the 19 buildings.

Questionnaire study

The questionnaire included questions on the work, its type, previous and present diseases, presence of symptoms from the mucous membranes, presence of general symptoms, and the frequency and time variations of such symptoms. Questions about various other symptoms, complaints about the indoor climate (draft, low temperature, etc), family and housing conditions, exercise habits, and consumption of tobacco, alcohol and other beverages were also included.

The possible categories of answers to the questions about individual symptoms were: “no,” “yes, some times a year,” “yes, some times a month,” “yes, some times a week,” and “yes, daily.” We also asked about variation in the degree of symptoms, for which we employed the following categories of answers: “yes, it improves at work,” “yes, it improves on days off/during weekends or vacations,” “no, it is always the same,” and “don’t know.” If a particular symptom occurred some times a week or more and improved on days off, the symptom was classified as work-related.

Besides single symptoms, we employed two groups of work-related symptoms, ie, work-related irritation of the mucous membranes (at least one of the work-related symptoms of irritation or dryness of the mucous membrane of the eye, nose, or throat) and work-related general symptoms (at least one of the

| Age (years) | Men | Women |
|------------|-----|-------|
| < 20       | 8   | 34    |
| 20—29      | 197 | 462   |
| 30—39      | 309 | 735   |
| 40—49      | 267 | 610   |
| 50—59      | 213 | 395   |
| 60—69      | 115 | 110   |
| Total      | 1109| 2346  |

| Length of office work (years) | Men | Women |
|------------------------------|-----|-------|
| 0—9                         | 306 | 692   |
| 10—19                       | 324 | 755   |
| 20—29                       | 234 | 585   |
| ≥ 30                        | 238 | 266   |
| Total                       | 1102| 2298  |

| Job category          | Men | Women |
|-----------------------|-----|-------|
| Mayor, director       | 85  | 6     |
| Principal             | 171 | 25    |
| Head clerk            | 299 | 619   |
| Clerk                 | 163 | 1043  |
| Probationary clerk    | 70  | 201   |
| Social worker         | 24  | 159   |
| Technical assistant   | 25  | 47    |
| Engineer or architect | 187 | 19    |
| Other                 | 82  | 219   |
| Total                 | 1106| 2338  |

Table 1. Participants by sex, age, length of time in office work, and job category.
work-related symptoms of headache, abnormal fatigue, or malaise.

Statistical methods

The significance of single factors in the total population of office workers was evaluated by the chi-square test.

The multifactorial effects on the prevalences were analyzed in a logistic regression model according to Breslow & Day (12), in which the probability of response is related to a set of regression variables \(x=(x_1,..., x_p)\) via the following equation:

\[
P(x) = \frac{\exp(a + \sum \beta_j x_j)}{1 + \exp(a + \sum \beta_j x_j)}
\]

In our case, the probability for each individual to develop the symptom was expressed as a function of the characteristics of that same person. The betas are parameters to be estimated. These parameters were interpreted via the odds ratio. For individuals with characteristics \(x\) and \(x^*\), respectively, the odds ratio was

\[
\exp[\Sigma \beta_j(x_j - x_j^*)]
\]

The 95% confidence interval of the odds ratios was estimated from the corresponding confidence interval of \(\hat{\beta} \pm 1.96 \text{ SD} (\hat{\beta})\).

Because of the very large number of factors investigated, we used a modified backward elimination procedure. First, one set of important variables was analyzed, i.e., building, sex, age, job category, seniority, and weekly workhours. The relative importance of these variables was judged from the single factor analysis and from the results of other studies. The model was reduced with a standard backward elimination procedure until only factors jointly significant at the 5% level were retained. These factors were considered together with the variables on work function, and a similar stepwise reduction was performed. The resulting model was analyzed, together with two different groups of variables, for psychosocial aspects of the work and personal characteristics. Again the same stepwise elimination was carried out. Finally, all independent variables retained in the foregoing analysis at a 5% significance level were included in the final model, and a last backward elimination was performed. In this last model, only variables with a significant influence at the 1% level were retained.

For several independent variables, different scorings were tried, but in the final analysis many were dichotomized. Variables such as age, seniority, work-hours, and number of clients served per day (and others) were divided into three or five groups and analyzed as continuous variables as well. The job categories, although not all significantly different, were kept separate, as there were no natural combinations and as a combination directly based on prevalences would have been different for the mucosal irritation symptoms and the general symptoms.

Apart from the variables included in this report, many others were investigated, and the interactions between some of the significant variables were tested. For example, it was determined whether the differences between the sexes or between the job categories remained constant across the buildings. There were no marked indications of interactions between the buildings and the other significant effects.

In the analyses, the buildings were separated by a categorical variable (highly significant). In a subsequent paper this variable will be replaced by the measurements of the indoor environment in the individual town halls.

Results

Personal characteristics

In table 2 the association between certain personal characteristics of the subjects and the prevalence of work-related symptoms is shown, together with the estimated odds ratios from the final model of the logistic regression analyses. The factors shown are some basic characteristics and information given by the subjects on diseases relevant to the context of the sick building syndrome (allergy in the family, hay fever, and migraine).

The women had a substantially higher symptom prevalence than the men. Only in the first multivariate model containing the variables of building, sex, job category, and number of workhours weekly or number of hours in one's office per day was the odds ratio for women somewhat reduced compared with the crude odds ratio. In the other models of the multivariate analysis, the odds ratio did not change much during the steps. Other than sex, only hay fever and migraine were significantly associated with the symptoms in the multivariate analysis. Hay fever had an (expected) effect on work-related mucosal irritation, and migraine was associated with the work-related general symptoms (also expected).

Life-style and residential factors

The life-style factors, i.e., smoking, alcohol and coffee consumption, and exercise, were only weakly associated with the symptoms. However, there was a somewhat increased frequency of work-related general symptoms among the smokers, whereas coffee drinkers tended to have a lower frequency of work-related mucosal irritation (table 3). People wearing contact lenses had a higher frequency of work-related mucosal irritation than the others.

Housing conditions seemed to have an effect on both work-related mucosal irritation and work-related general symptoms. People living in apartments tended to have a slightly higher prevalence of both work-related mucosal and work-related general symptoms than those living in other kinds of dwellings. Persons with small children or with indoor climate problems
Table 2. Prevalence of work-related symptoms (%) among the office workers by personal characteristics. (N = number of persons in the category, % = symptom prevalence, P = P-value of the chi-square test, OR = odds ratio estimated from the final model of the logistic regression analysis, 95 % CI = 95 % confidence interval, NS = nonsignificant in the multivariate analysis)

|                      | Mucosal irritation | General symptoms |
|----------------------|-------------------|------------------|
|                      | N %   | P  | OR  | 95 % CI | N %   | P  | OR  | 95 % CI |
| Sex                  |        |    |     |        |        |    |     |        |
| Male                 | 1024   | 20 | 1   |        | 1023  | 26 | 1   |        |
| Female               | 2118   | 33 | 1.6 | 1.3—2.1| 2110  | 42 | 1.8 | 1.5—2.3|
| Age (years)          |        |    |     |        |        |    |     |        |
| < 40                 | 1646   | 29 | NS  |        | 1641  | 40 | NS  |        |
| ≥ 40                 | 1493   | 28 | NS  |        | 1489  | 33 | NS  |        |
| Marital status       |        |    |     |        |        |    |     |        |
| Married              | 2437   | 27 | NS  |        | 2430  | 36 | NS  |        |
| Single               | 736    | 32 | NS  |        | 735   | 39 | NS  |        |
| Allergic disposition |        |    |     |        |        |    |     |        |
| No                   | 2440   | 28 | NS  |        | 2433  | 35 | NS  |        |
| Yes                  | 693    | 29 | NS  |        | 691   | 42 | NS  |        |
| Hay fever            |        |    |     |        |        |    |     |        |
| No                   | 2694   | 27 | 1   |        | 2688  | 35 | NS  |        |
| Yes                  | 447    | 37 | 1.6 | 1.2—2.0| 445   | 46 | NS  |        |
| Migraine             |        |    |     |        |        |    |     |        |
| No                   | 2547   | 26 | NS  |        | 2539  | 33 | 1   |        |
| Yes                  | 604    | 37 | NS  |        | 603   | 52 | 1.8 | 1.4—2.2|

Table 3. Prevalence of work-related symptoms (%) among the office workers by life-style and residential factors. (N = number of persons in the category, % = symptom prevalence, P = P-value of the chi-square test, OR = odds ratio estimated from the final model of the logistic regression analysis, 95 % CI = 95 % confidence interval, NS = nonsignificant in the multivariate analysis)

|                      | Mucosal irritation | General symptoms |
|----------------------|-------------------|------------------|
|                      | N %   | P  | OR  | 95 % CI | N %   | P  | OR  | 95 % CI |
| Smoking (g/d)        | 0.36  |    |     |        | 0.0004 |    |     |        |
| <10                  | 1992  | 28 | NS  |        | 1986  | 34 | 1   |        |
| ≥10                  | 1142  | 30 | NS  |        | 1139  | 41 | 1.3 | 1.1—1.6|
| Alcohol on weekdays  | 0.19  |    |     |        | 0.18   |    |     |        |
| (drinks/d)           |        |    |     |        |        |    |     |        |
| 0                    | 1532  | 30 | NS  |        | 1527  | 38 | NS  |        |
| 1—4                  | 1346  | 27 | NS  |        | 1343  | 35 | NS  |        |
| >4                   | 74    | 23 | NS  |        | 74    | 38 | NS  |        |
| Coffee (cups/d)      | 0.0009 |   |     |        | 0.22   |    |     |        |
| 0                    | 478   | 34 | 1   |        | 477   | 40 | NS  |        |
| 1—6                  | 2005  | 26 | 0.6 | 0.5—0.8| 1997  | 36 | NS  |        |
| >6                   | 666   | 31 | 0.8 | 0.6—1.1| 666   | 36 | NS  |        |
| Regular exercise     | 0.33  |    |     |        | 0.02   |    |     |        |
| No                   | 1443  | 28 | NS  |        | 1435  | 39 | NS  |        |
| Yes                  | 1659  | 29 | NS  |        | 1658  | 35 | NS  |        |
| Contact lenses       | 0.03  |    |     |        | 0.95   |    |     |        |
| No                   | 2964  | 28 | NS  |        | 2955  | 37 | NS  |        |
| Yes                  | 164   | 36 | NS  |        | 164   | 37 | NS  |        |
| Residence            | 0.004 |    |     |        | 0.0004 |    |     |        |
| Flat                 | 1154  | 31 | NS  |        | 1153  | 40 | NS  |        |
| Other                | 2018  | 27 | NS  |        | 2011  | 35 | NS  |        |
| Household with children <3 years of age | 0.48 |    |     |        | 0.01   |    |     |        |
| No                   | 2885  | 29 | NS  |        | 2878  | 36 | NS  |        |
| Yes                  | 285   | 27 | NS  |        | 284   | 44 | NS  |        |
| Indoor climate problems in the residence | 0.34 |    |     |        | <0.0001 |    |     |        |
| No                   | 2825  | 28 | NS  |        | 2820  | 35 | 1   |        |
| Yes                  | 339   | 31 | NS  |        | 336   | 48 | 1.6 | 1.3—2.2|
in their residence seemed to suffer from more work-related general symptoms than other persons. However, the effect of these housing conditions was insignificant in the multivariate analysis, except for indoor climate problems in the residence (table 3).

**Job category**

Table 4 shows that work-related mucosal irritation and work-related general symptoms were frequent in the clerk categories. The effect of job category gradually diminished during the steps of the multivariate analysis when information on the type of work, etc., was included in the model, especially for the clerk categories and social workers. For work-related mucosal irritation, the reduction was the most marked when the covariates for type of work and workhours in the office were added to the model. For work-related general symptoms, the most marked reduction was seen when the psychosocial factors of work were added. The odds ratio for work-related mucosal irritation among the clerks was, for example, reduced from 5.2 to 3.1 and that of work-related general symptoms among the social workers from 3.8 to 2.1.

**Seniority, type of office and workhours**

The small and weak effect of length of time in office work and number of occupants in the office was insignificant in the multivariate analysis (table 5). Num-

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**Table 4.** Prevalence of work-related symptoms (%) among the office workers by job category. (N = number of persons in the category, % = symptom prevalence, OR = odds ratio estimated from the final model of the logistic regression analyses, 95 % CI = 95 % confidence interval)

| Category                      | N  | %  | OR 95 % CI | N  | %  | OR 95 % CI |
|-------------------------------|----|----|------------|----|----|------------|
| Mucosal irritation            |    |    |            |    |    |            |
| Mayor or director             | 91 | 10 | 1.0        | 91 | 19 | 1.0        |
| Principal                     | 198| 20 | 2.5        | 188| 23 | 1.1        |
| Head clerk                    | 927| 29 | 2.7        | 923| 35 | 1.2        |
| Clerk                         | 1222| 35 | 3.1        | 1218| 42 | 1.6        |
| Probationary clerk            | 277| 27 | 1.7        | 276| 43 | 1.9        |
| Social worker                 | 186| 23 | 1.8        | 186| 51 | 2.1        |
| Technical assistant           | 73 | 18 | 1.1        | 73 | 19 | 0.8        |
| Engineer or architect         | 206| 10 | 1.7        | 206| 18 | 1.0        |
| General symptoms              |    |    |            |    |    |            |
| Mayor or director             | 91 | 19 | 1.0        | 91 | 19 | 1.0        |
| Principal                     | 198| 23 | 1.1        | 188| 21 | 1.0        |
| Head clerk                    | 927| 35 | 1.2        | 923| 36 | 1.2        |
| Clerk                         | 1222| 42 | 1.6        | 1218| 42 | 1.6        |
| Probationary clerk            | 277| 43 | 1.9        | 276| 43 | 1.9        |
| Social worker                 | 186| 51 | 2.1        | 186| 51 | 2.1        |
| Technical assistant           | 73 | 19 | 0.8        | 73 | 19 | 0.8        |
| Engineer or architect         | 206| 18 | 1.0        | 206| 18 | 1.0        |

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**Table 5.** Prevalence of work-related symptoms (%) among the office workers by seniority, type of office, workhours, time spent in the office, and hours working outside the town hall. (N = number of persons in the category, % = symptom prevalence, P = P-value of the chi-square test, OR = odds ratio estimated from the final model of the logistic regression analyses, 95 % CI = 95 % confidence interval, NS = nonsignificant in the multivariate analysis)

| Category                      | N  | %  | P  | OR 95 % CI | N  | %  | P  | OR 95 % CI |
|-------------------------------|----|----|----|------------|----|----|----|------------|
| Mucosal irritation            |    |    |    |            |    |    |    |            |
| Length of time in office work (years) |    |    | 0.76 | 0.01 |    |    | 0.76 | 0.01 |
| <20                           | 1880| 29 | NS |           | 1875| 39 | NS |           |
| ≥20                           | 1284| 28 | NS |           | 1280| 34 | NS |           |
| Number of occupants in the office |    |    | <0.0001 | 0.93 |    |    | <0.0001 | 0.93 |
| 1                             | 947 | 24 | NS |           | 944 | 33 | NS |           |
| 2-4                           | 1393| 27 | NS |           | 1389| 35 | NS |           |
| ≥5                            | 831 | 36 | NS |           | 829 | 44 | NS |           |
| Workhours (h/week)            |    |    | 0.93 | 0.02 |    |    | 0.93 | 0.02 |
| <20                           | 202 | 28 | NS |           | 200 | 29 | 1 |           |
| 21-39                         | 530 | 28 | NS |           | 579 | 40 | NS |           |
| ≥40                           | 2390| 29 | NS |           | 2374| 37 | 1.6 | 0.8-3.5 |
| Length of time in the office (h/d) |    |    | <0.0001 | 1.76 |    |    | <0.0001 | 1.76 |
| ≤6                            | 944 | 23 | 1  |           | 941 | 31 | NS |           |
| 7                             | 1012| 33 | 1.5 | 1.2-1.9   | 1008| 37 | NS |           |
| ≥8                            | 1199| 30 | 1.1 | 0.9-1.4   | 1197| 41 | NS |           |
| Length of time working outside the town hall (h/week) |    |    | <0.0001 | 1.76 |    |    | <0.0001 | 1.76 |
| ≤5                            | 2875| 30 | NS |           | 2866| 38 | NS |           |
| >5                            | 235 | 14 | NS |           | 235 | 22 | NS |           |

* Analyzed as a continuous variable: the OR for a full-time (40 h) compared with a part-time (20 h) office worker is 1.6 (p = 0.023774/h).
number of workhours per week, when analyzed as a continuous variable, and hours in one’s office during the day had a significant effect on the prevalence of work-related mucosal irritation and work-related general symptoms. These two covariates were significant in the multivariate analysis when added separately to the model. When they were added together, only number of workhours per week had an effect on work-related general symptoms, whereas hours in one’s office per day had an effect on work-related mucosal irritation (table 5). The effect of number of hours worked outside the town hall building became insignificant in a model containing workhours per week and hours in one’s office per day.

**Type of work**
Various common types of work in a town hall office, other than writing and typing (which were not asked about) were related to the prevalence of symptoms (table 6). It was found that the handling of carbonless paper and the handling of carbon paper were significantly associated with the occurrence of work-related mucosal irritation and work-related general symptoms, as were photocopying and work at video display terminals. The number of clients was clearly associated with the occurrence of work-related general symptoms, but not with work-related mucosal irritation.

In the multivariate analysis, the handling of carbonless paper was the only covariate with a significant effect on work-related general symptoms.

Handling carbonless paper weekly or daily, photocopying more than 25 sheets weekly, and working at a video display terminal more than 1 h some times a week or daily had a significant effect on work-related mucosal irritation.

**Psychosocial factors**
All the psychosocial factors of work examined are shown in table 7. They were all strongly associated with either work-related mucosal irritation or work-related general symptoms in the multivariate analysis when added separately to the model. When all the psychosocial factors were included in the analysis, only dissatisfaction with one’s superior and the feeling that the quantity of work inhibits one’s job satisfaction had a significant effect on work-related mucosal irritation. The possible mental strain of the combination of little influence on the organization of the daily work and a high work pace has been suggested by Karasek et al (20). In the present study it was self-assessed, and office workers considering their work pace too fast and feeling that they had only some or little influence on the organization of their daily work had a significantly higher odds ratio for general symptoms. The test probability for the effect of job category and the com-

| Table 6. Prevalence of work-related symptoms (%) among the office workers by work function. (N = number of persons in the category, % = symptom prevalence, P = P-value of the chi-square test, OR = odds ratio estimated from the final model of the logistic regression analyses, 95 % CI = 95 % confidence interval, monthly or less = no, sometimes a year or sometimes a month, weekly or daily = some times a week or daily, NS = nonsignificant in the multivariate analysis) |
|---------------------------------------------------------------|
| **Mucosal irritation** | **General symptoms** |
| N % | P | OR | 95 % CI | N % | P | OR | 95 % CI |
| Handling carbonless paper | <0.0001 | <0.0001 |
| Monthly or less | 1648 | 24 | 1 | 1643 | 31 | 1 |
| Weekly or daily | 1290 | 32 | 1.3 | 1.1—1.6 | 1288 | 41 | 1.4 | 1.1—1.7 |
| ≤ 25 forms | 183 | 43 | 1.3 | 1.1—1.6 | 181 | 56 | 1.6 | 1.1—1.7 |
| > 25 forms | 183 | 43 | 1.3 | 1.1—1.6 | 181 | 56 | 1.6 | 1.1—1.7 |
| Handling carbon paper | <0.0001 | <0.0001 |
| Monthly or less | 1855 | 25 | NS | 1849 | 33 | NS |
| Weekly or daily | 1243 | 33 | 1 | 1240 | 41 | 1 |
| ≤ 25 forms | 67 | 39 | 1 | 67 | 52 | 1 |
| > 25 forms | 67 | 39 | 1 | 67 | 52 | 1 |
| Photocopying | <0.0001 | 0.002 |
| Monthly or less | 233 | 22 | 1 | 233 | 30 | 1 |
| Weekly or daily | 2490 | 27 | 1.5 | 1.2—2.0 | 2484 | 36 | 1.5 | 1.2—2.0 |
| ≤ 25 sheets | 447 | 37 | 1.5 | 1.2—2.0 | 444 | 43 | 1.5 | 1.2—2.0 |
| > 25 sheets | 447 | 37 | 1.5 | 1.2—2.0 | 444 | 43 | 1.5 | 1.2—2.0 |
| Work at video display terminals | <0.0001 | 0.02 |
| Monthly or less | 2005 | 26 | 1 | 2001 | 35 | 1 |
| Weekly or daily | 849 | 30 | 1.6 | 1.2—2.1 | 845 | 40 | 1.6 | 1.2—2.1 |
| ≤ 1 h | 308 | 41 | 1.6 | 1.2—2.1 | 307 | 41 | 1.6 | 1.2—2.1 |
| > 1 h | 308 | 41 | 1.6 | 1.2—2.1 | 307 | 41 | 1.6 | 1.2—2.1 |
| Number of clients per day | 0.18 | 0.008 |
| 0 | 872 | 27 | 1 | 870 | 33 | 1 |
| 1—5 | 1313 | 28 | NS | 1310 | 37 | NS |
| 6—10 | 384 | 30 | NS | 383 | 41 | NS |
| > 10 | 325 | 33 | NS | 325 | 41 | NS |
Table 7. Prevalence of work-related symptoms (%) among the office workers by psychosocial factors. (N = number of persons in the category, % = symptom prevalence, \( P \) = P-value of the chi-square test, \( OR \) = odds ratio estimated from the final model of the logistic regression analyses, 95% CI = 95% confidence interval, NS = nonsignificant in the multivariate analysis)

|                      | Mucosal irritation | General symptoms |
|----------------------|-------------------|------------------|
|                      | N  | %  | \( \hat{OR} \) | 95% CI | N  | %  | \( \hat{OR} \) | 95% CI |
| Influence on organization of the daily work |      |    |             |       |      |    |             |       |
| High                 | 1384 | 25 | <0.0001 |        | 1380 | 32 | <0.0001 |        |
| Low                  | 1778 | 31 | NS        |        | 1773 | 40 | NS        |        |
| Varied work          |      |    | <0.0001 |        |      |    | <0.0001 |        |
| Yes                  | 2039 | 26 |        |        | 2035 | 34 |        |        |
| No                   | 1128 | 33 | NS        |        | 1123 | 42 | 1.3 | 1.1—1.6 |
| Satisfaction with superior |      |    | <0.0001 |        |      |    | <0.0001 |        |
| Yes                  | 2296 | 26 | 1        | 1.4—2.0 | 2290 | 34 |        |        |
| No                   | 829  | 36 | NS        |        | 826  | 44 | NS        |        |
| Satisfaction with colleagues |      |    | 0.002 |        |      |    | <0.0001 |        |
| Yes                  | 2226 | 27 |        |        | 2720 | 34 |        |        |
| No                   | 437  | 35 | NS        |        | 434  | 52 | 2.0 | 1.6—2.6 |
| Work speed           |      |    | 0.11 |        |      |    | <0.0001 |        |
| Not too fast         | 2236 | 28 | 1        |        | 2230 | 34 |        |        |
| Too fast             | 923  | 30 | NS        |        | 920  | 43 | NS        |        |
| Quantity of work inhibits job satisfaction |      |    | <0.0001 |        |      |    | <0.0001 |        |
| No                   | 1610 | 25 | 1        |        | 1606 | 30 | 1        |        |
| Yes                  | 1547 | 32 | 1.4 | 1.1—1.7 | 1544 | 44 | 1.7 | 1.4—2.1 |
| Little influence and high workplace |      |    | 0.002 |        |      |    | <0.0001 |        |
| No                   | 2666 | 27 | 1        |        | 2658 | 34 | 1        |        |
| Yes                  | 476  | 34 | NS        |        | 475  | 50 | 1.4 | 1.1—1.7 |

Combination of little influence and high work speed varied just about 0.01 in the last step of the stepwise procedure of the multivariate analysis (2572 persons) and in the final model (2597 persons). Thus both were retained in the model.

The buildings

In figure 1 the crude odds ratios for the occurrence of work-related mucosal irritation and work-related general symptoms in the 19 buildings included in the study are shown along with the adjusted odds ratios. The adjusted odds ratios were derived from the final model in the multivariate analysis. Some buildings changed their rank order, and in some cases the difference between the crude and adjusted odds ratio was substantial in comparison with the variation between the buildings. But the odds ratio between the buildings with the highest prevalence and those with the lowest prevalence was still about three.

Discussion

This study was not undertaken at the request of either the management or the employees, as most studies of the sick building syndrome have been (13, 14). The buildings and their employees were chosen because we wanted to examine a uniform population with equal socioeconomic status and type of work, but exposed to different indoor climate conditions.

We have previously reported that the many indoor climate factors determined in this study resulted in values mainly at the levels normally considered acceptable or in values in accordance with levels previously reported. However, there was a considerable variation between the buildings as to some of the indoor climate parameters (11). The prevalence of work-related mucosal irritation and work-related general symptoms differed between the buildings too, and the symptom prevalence was significantly associated with sex and some job-related factors.

Using multivariate logistic regression analyses, we have studied these and other potential risk factors for the symptoms. An important finding was that, although work-related mucosal irritation and work-related general symptoms were significantly associated with some of the personal characteristics, job-related factors, and psychosocial factors of work, there was still a highly significant association between the symptoms and the building factor. Thus the observed differences in prevalences among the populations in the buildings cannot be explained by different compositions of employees.

Among the many personal characteristics, life-style factors, and residential factors analyzed, sex seemed to be the most important risk factor. In common with other studies, our investigation revealed that women had a higher prevalence of work-related mucosal irritation and work-related general symptoms than men.
(10, 15), even when other important factors, such as job category, were taken into consideration.

Persons with a medical history of hay fever (14%) had a higher risk for work-related mucosal irritation, probably owing to the nonspecific hypersensitivity of the mucous membrane connected with this disease.

Persons suffering from migraine had a higher risk for work-related general symptoms, a reasonable finding, since work-related headache is one of the symptoms in the group of work-related general symptoms. In an interview study of a random sample of the adult Danish population, smoking was significantly associat-

![MUCOSAL IRritATION](image)

![GENERAL SYMPTOMS](image)

Figure 1. Crude and adjusted odds ratio determined for work-related mucosal irritation (upper figure) and work-related general symptoms (lower figure) among the office workers in 19 buildings. (The crude odds ratio is shown by the filled-in bars and the adjusted odds ratio by the hatched bars). The adjusted odds ratio was estimated from the final model of the logistic regression analysis.
ed with both work-related mucous membrane irritation and work-related headache (10). In this study, smoking more than 10 g of tobacco a day was significantly associated only with the occurrence of work-related general symptoms, and the effect was weak (odds ratio 1.3).

Coffee is known to have a symptom-relieving effect on headache, but there was no association between coffee consumption and work-related general symptoms in our analyses. However, people drinking coffee had a lower risk for work-related mucosal irritation than those not drinking coffee. This is probably a casual finding; it might also be that those who do not drink coffee form a sensitive section of the population.

A minor portion (11%) of the office workers reported a variety of indoor climate problems in their residence. Generally, they had a higher risk for work-related general symptoms than those without such problems.

The job-related factors seem to be important risk factors for work-related mucosal irritation and work-related general symptoms. Work hours per week and the average hours per day which the office worker stayed in the same office during a workweek somehow reflect the same job-related factor, since in the multivariate analyses they were mutually exchangeable. People staying 7 h/d had more work-related symptoms than those staying less and also more work-related symptoms than those staying 8 h or more; this finding suggests that the problem was not merely a matter of the number of hours spent in the office.

Handling carbonless paper, photocopying, and working with video display terminals have previously been found to be associated with work-related mucosal irritation and work-related general symptoms (16, 17). Although this population of office workers handled only minor quantities of carbonless paper, photocopied few sheets of paper, and worked few hours at a terminal, these factors were significantly associated with the work-related symptom prevalence. This finding emphasizes the importance of considering these factors in the study of indoor climates.

Some of the influence of job category on the prevalence of work-related mucosal irritation and work-related general symptoms could be ascribed to work function and psychosocial factors of work, but, even when adjusted for these covariates, job category still showed a highly significant association with this prevalence. The effect of job category could either be due to uninvestigated work functions and psychosocial factors or to a general tendency to allocate a different indoor climate to the different job categories.

Social and psychological aspects of work have been related to complaints about indoor climate and work-related symptoms (5), and in some cases employees have been accused by employers of being hysterical. The symptom pattern of the sick building syndrome is not very typical for mass psychogenic illness, and the course of the sick building syndrome is endemic rather than epidemic in contrast to mass hysteria (18, 15), even though the possibility of major psychogenic factors has to be considered.

Indeed, highly significant associations between the work-related symptom prevalence and the psychosocial factors were found, and, as expected, the impact on the occurrence of work-related general symptoms was more pronounced than that on work-related mucosal irritation. However, the psychosocial factors asked about in this study could not explain the overall variation between the buildings as to work-related symptom prevalence, but the multivariate analyses indicated that these factors had a substantial impact on the recorded differences between the job categories. It is interesting to note that the adjusted odds ratios for work-related general symptoms were higher for persons who felt that their workspace was high and that they had little influence on work organization, a combination which is considered to produce mental stress (20).

The symptoms and the independent variables were derived from the questionnaire, but information about age, sex, job category, and building was checked from the data of the clinical study and employment lists. The other factors were based on self-reported information, and people suffering from symptoms may be highly aware of what they are exposed to or those exposed to suspected factors may report symptoms more frequently. In both cases the associations between the occurrence of symptoms and the exposure to carbonless paper, photocopying, and video display terminals would be explained. However, the study was introduced as a general study of the indoor environment that especially emphasized the measurement of the indoor climate, and the results are in accordance with those of other such studies.

This study dealt with a selected population of office workers in a geographically selected population of buildings and thus was not intended to be a representative sample of all office workers or even civil servants. Nevertheless, the prevalence of work-related mucosal irritation reasonably agrees with that of a study of a representative sample of the adult Danish population (10), in which the estimated prevalence of work-related mucosal irritation at work for office workers was 44% for women and 25% for men, in comparison with 21% for women and 12% for men in the general population.

In conclusion, the building factor was strongly associated with the prevalence of work-related mucosal irritation and work-related general symptoms, and the results supported the concept of using the term "sick building syndrome," but other factors such as sex, job-related factors, and psychosocial factors must be accounted for. Whether the building factor is related to special characteristics of the building or to the measurements of the indoor climate will be discussed in a subsequent paper.
Acknowledgments

This work was supported by grants from the Rock-wool Foundation, the Scandinavian Tobacco Company, Wiggins Teape, the Health Foundation, and the Working Environment Foundation.

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Received for publication: 7 April 1988