Sick Building Syndrome: Psychological, Somatic, and Environmental Determinants

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ABSTRACT. The authors aimed to examine potential relationships between work-related symptoms attributed to sick building syndrome (SBS) and certain psychological, somatic, and environmental factors. The multidisciplinary, cross-sectional study comprised 171 female subjects working in air-conditioned and naturally ventilated nonindustrial office buildings. The authors collected information concerning symptoms related to SBS and made assessments of quality of life by using appropriate questionnaires. They assessed the women’s levels of emotional stability or neuroticism using the Cornell Index. They determined skin and airway reactivity markers and indoor microclimate data by using standardized methods. The study showed that the subjects had a high prevalence of fatigue (60.2%), sore and dry eyes (57.9%), and headache (44.4%), as well as a generally high score according to the SBS Index. Neuroticism and subjectively estimated physical health as well as the type of building ventilation significantly contributed to the prediction of the SBS Index, explaining 15% of the variance.

KEYWORDS: air conditioning, airway reactivity, atopy, female office workers, psychological factors, sick building syndrome

Sick building syndrome (SBS) is defined as an environmentally related condition with increased prevalence of nonspecific symptoms among the populations of certain buildings, absence of clinical signs, and poor or no objective measures of symptoms. SBS should be distinguished from building-related illness, which is better defined with the presence of specific medical diagnoses (eg, allergy, asthma, infection, poisoning) and is etiologically connected with building characteristics such as poor construction, ventilation system problems, or established toxic exposure. SBS is considered a multifactorial health problem, which could be described with a biopsychosocial model by Spurgeon and coworkers. The model has 3 interactive paths for the SBS symptoms: somatic (atopy, mucosal hyperreactivity), psychosocial (stress, personality, behavior, and sociological factors), and environmental (physical, biological, and chemical hazards). Many authors have studied the SBS within the framework of this model, with results that to this point have been controversial regarding its medical definition, course, and prognosis. Results of published studies have consistently shown that women are more prone than men to be affected with SBS and that occupants of air-conditioned buildings report more symptoms than do occupants of naturally ventilated buildings.

SBS is usually experienced by many people in a group, but individual risk factors may be important in sick-role susceptibility. Therefore, we studied the concurrent role and relative contribution of somatic, psychological, and environmental factors in the prediction of SBS symptoms in female

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office workers. We tested 3 hypotheses: (1) women working in air-conditioned buildings report SBS symptoms more often than do those working in naturally ventilated buildings, (2) certain aspects of psychological characteristics affect SBS symptomatology in both groups of employees, and (3) SBS symptoms are more often reported by atopic subjects than by other subjects.

**METHODS**

**Subjects and Study Protocol**

We designed this study as a cross-sectional study, involving female office workers from Zagreb, Croatia. We invited employees from 7 office buildings to participate: 4 of the buildings were naturally ventilated and 3 were air-conditioned. Officials from 5 buildings responded positively: 3 were from naturally ventilated and 2 were from air-conditioned buildings (see Table 1).12

From these 5 buildings, we recruited 171 female office workers on a voluntary basis after an announcement given by their employers. We divided them into 2 groups: the first consisted of women who worked in naturally ventilated offices (n = 78), and the second consisted of women who worked in fully air-conditioned buildings (n = 93). Descriptive characteristics are presented in Table 2. Study protocol is presented in Figure 1.

Each employee interested in participating was informed about the study protocol and signed a consent form. During the initial medical interview and physical examination, we evaluated women for contraindications for the clinical tests included in the study; only those with no contraindications participated further. We designed the study in accordance with the Helsinki declaration, and it was approved by the authorized ethical committee.

**Building Characteristics**

Inspection visits to all naturally ventilated buildings established an impression of a common office indoor environment with no signs of microclimate discomfort or dusty environment in the majority of offices. All workplaces prohibited smoking inside the premises.

We had data on indoor microclimate conditions (air temperature and humidity) and total dust exposure in air-conditioned buildings checked periodically by licensed firms according to Croatian rules (regulations on protection of the workplace for main and auxiliary working room and spaces, 1984; regulation on maximal permitted concentrations of harmful substances in the air of working rooms and spaces, 1993). According to official reports, microclimate conditions and total dust concentrations were within permitted limits (air temperature range, 22°C–25°C; relative air humidity range, 40%–60%; total dust concentrations, <10 mg/m³ in all air-conditioned buildings).

**Sick Building Syndrome Questionnaire**

Using the Sick Building Syndrome Questionnaire, we assessed work-related health symptoms and complaints that are commonly attributed to indoor air quality problems by means of standardized questions to all women.12,13 The participants were asked whether they have experienced any of 10 symptoms (fatigue, eye irritation, throat irritation, trouble in concentrating, headache, cough, nose irritation, sneezing, cold, skin irritation) in their workplaces on 3 days or more during the previous 2 weeks. The SBS Index was expressed as the number of 10 potential work-related health complaints or symptoms in the previous 2-week period per worker, expressed within the range 1.0 (no symptoms) to 2.0 (all symptoms present). The SBS Index (SBS symptoms' score) is characterized in more than 2 values and has a clearly implied direction from better to worse, with 1.0 being no symptoms, 1.1 being one symptom, 1.2 being two symptoms, and so on.

**Psychosocial Factors**

**World Health Organization Quality-of-Life Questionnaire**

We used a short form of the World Health Organization Quality-of-Life Questionnaire (WHOQOL-BREF) to measure an individual's perception of her quality of life in the previous 2-week period. The WHOQOL-BREF incorporates estimates of a person's physical health (pain, dependence on

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**Table 1.—Office Building Characteristics According to the Heating, Ventilation, and Air-Conditioning System**

<table>
<thead>
<tr>
<th>Office building</th>
<th>n</th>
<th>Ventilation</th>
<th>Cooling</th>
<th>Central heating</th>
<th>Humidification/dehumidification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naturally ventilated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>41</td>
<td>Windows</td>
<td>Decentralized</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>9</td>
<td>Windows</td>
<td>Decentralized</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>28</td>
<td>Windows</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air conditioned</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>22</td>
<td>Centralized</td>
<td>Centralized</td>
<td>Centralized</td>
<td>Centralized</td>
</tr>
<tr>
<td>2</td>
<td>71</td>
<td>Centralized</td>
<td>Centralized</td>
<td>Centralized</td>
<td>Centralized</td>
</tr>
</tbody>
</table>

*Note: A centralized system has ducts, fans, cooling coils, and humidifiers/dehumidifiers with air recirculation.*
### Table 2. Descriptive Statistics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Subjects from naturally ventilated buildings (n = 78)</th>
<th>Subjects from air-conditioned buildings (n = 93)</th>
<th>All subjects (N = 171)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Age (y)</td>
<td>78</td>
<td>44.8</td>
<td>9.2</td>
</tr>
<tr>
<td>Work exposure (y)</td>
<td>78</td>
<td>16.5**</td>
<td>1.1-36</td>
</tr>
<tr>
<td>Smokers</td>
<td>26</td>
<td>33.3</td>
<td>33.3</td>
</tr>
<tr>
<td>SBS-related symptom</td>
<td>59</td>
<td>75.6*</td>
<td>90.3*</td>
</tr>
<tr>
<td>SBS index</td>
<td>59</td>
<td>1.30**</td>
<td>0.21</td>
</tr>
<tr>
<td>Psychosocial factor</td>
<td>59</td>
<td>17.4</td>
<td>11.4</td>
</tr>
<tr>
<td>Cornell Index</td>
<td>78</td>
<td>15.7</td>
<td>2.40</td>
</tr>
<tr>
<td>WHOQOL-D1</td>
<td>78</td>
<td>15.1</td>
<td>2.43</td>
</tr>
<tr>
<td>WHOQOL-D2</td>
<td>78</td>
<td>15.8</td>
<td>2.92</td>
</tr>
<tr>
<td>WHOQOL-D3</td>
<td>78</td>
<td>14.1</td>
<td>2.30</td>
</tr>
<tr>
<td>WHOQOL-D4</td>
<td>78</td>
<td>189</td>
<td>139</td>
</tr>
<tr>
<td>Ateoy marker</td>
<td>78</td>
<td>6</td>
<td>3-12.5</td>
</tr>
<tr>
<td>SPT—histamine</td>
<td>29</td>
<td>21.5</td>
<td>0-1000</td>
</tr>
<tr>
<td>Positive SPT</td>
<td>77</td>
<td>0.29</td>
<td>1.41</td>
</tr>
<tr>
<td>Total IgE (IU/L)</td>
<td>70</td>
<td>2.88***</td>
<td>1.37</td>
</tr>
</tbody>
</table>

**Note.** For Total IgE, bronchial reactivity, and nasal reactivity: for subjects from naturally ventilated buildings, n = 77, 73, and 70, respectively; for subjects from air-conditioned buildings, n = 92, 85, and 85, respectively; and for all subjects, n = 169, 158, and 155 respectively. For SPT—histamine: for subjects from air-conditioned buildings, n = 92; and for all subjects, n = 170. SBS = sick building syndrome; WHOQOL = World Health Organization Quality of Life; SRRS = Social Readjustment Rating Scale; SPT = skin prick testing. Variables are as follows. Work exposure duration of work at present workplace; SBS index—number of (work-related health) SBS symptoms in the previous 1-week period per worker expressed within the range 0-2.0; WHOQOL-D1—WHOQOL-D4—scale results for perceived physical health, psychological health, social relations, and environment, respectively; SPT—histamine—mean skin reactivity to histamine solution (positive control) in the SPT; bronchial reactivity—nasal reactivity—slope of dose—response curve (natural logarithm of percentage change of forced expiratory volume in 1 second or total nasal airflow resistance after last histamine dose divided by a cumulative dose of applied histamine).

* p < .05, Pearson chi-square. ** p < .01, Mann–Whitney test. *** p < .01, Student’s t test.
medical treatment, energy, mobility, sleep, ability to carry out daily activities, and working capacity), psychological state (positive feelings, meaningfulness of life, ability to concentrate, acceptance of bodily appearance, satisfaction with oneself, and negative feelings), social relationships (personal relationships, sexual activity, and social support), and perception of salient features of a person’s environment (physical safety, healthy physical environment, financial resources, availability of information one needs, opportunities for recreation, quality of home environment, accessibility of health care, and transportation). Estimates are scored for the domains of physical health (WHOQOL-D1), psychological health (WHOQOL-D2), social relations (WHOQOL-D3), and environment (WHOQOL-D4). Each domain score ranges from 4 to 20, with higher scores denoting a higher quality of life.14

The Social Readjustment Rating Scale

We used the Social Readjustment Rating Scale (SRRS) to assess the stressfulness of a subject’s life.15 The SRRS is a list of 43 life events, such as death of a partner, divorce, death of a close family member, major business readjustment, taking a mortgage, change in residence, major change in sleeping habits, or minor violations of the law. The events are listed by rank order of their stressfulness and scored from 100 to 11 according to the scaling values of Miller and Rahe.16 Subjects marked events that occurred in their lives during the 12 months prior to questionnaire administration. We used the sum of scores for our analyses, with higher scores denoting higher stressfulness of life.

Cornell Index—Form N3

Cornell Index—Form N3 (henceforth called the Cornell Index) is a self-administered, true–false, multiscale measure of personality traits and psychosomatic disturbances. It consists of 100 questions, grouped in 12 scales: Hypersensitivity, Phobia, Anxiety, Depressiveness, Cardiovascular Conversions, Inhibitory Conversions, Gastric Conversions, Hypochondria, Obsessive-Compulsive Tendencies, Impulsive Tendencies, Aggression, and Psychopathic Tendencies. In addition, 10 questions cover a “lie scale” (L) with items of high desirability and low endorsement, and a “frequency scale” (F) with items of high desirability and high endorsement. The Cornell Index was assembled as a series of questions referring to symptom complexes, which could differentiate, with statistical reliability, persons with serious personality and psychosomatic disturbances from the rest of the population.17-21

As a result of the expected normal range of individual scores, we used the sum result for the whole Cornell Index Questionnaire for statistical analysis. The overall sum result indicates the level of emotional stability or neuroticism. Kulentović and Buško19 performed an empirical evaluation of the diagnostic and pragmatic utility of the Cornell Index on a sample of 348 prison inmates in Croatia.

Atopy Markers and Airway Reactivity

Skin Prick Testing

We performed skin prick testing (SPT) by the standard method22 with a panel of commercial common inhalatory
allergens (Allergopharma, Reinbeck, Germany). SPT included testing with a positive control solution (10 mg/mL of histamine hydrochloride) and a negative control solution (buffer solution). We evaluated the mean skin reaction (mean wheal diameter) after 15 minutes and calculated it according to the formula \( (D + d)/2 \), where \( D \) represents the largest longitudinal diameter and \( d \) its midpoint orthogonal diameter in millimeters. We analyzed the results of SPT as mean Urtica (nettle plant) levels to histamine in millimeters (SPT histamine) as the measure of nonspecific skin reactivity, and as mean wheal diameter to at least 1 tested allergen larger than negative control for 3 mm or more (positive SPT) as the measure of specific skin reactivity.

Total Serum IgE

We measured total serum IgE antibody from venous blood samples, using the enzyme-linked immunosorbent assay method (IASON, Graz, Austria).

Nonspecific Bronchial Challenge Test

We performed standard nonspecific nasal and bronchial challenge tests as upper- and lower-airway reactivity measures. We performed the nasal challenge 48 hours after the bronchial challenge.

We assessed nonspecific bronchial reactivity by means of a histamine challenge test according to the procedure described by Chai and colleagues. Subjects inhaled doubling concentrations of histamine diphosphate saline solutions (Sigma Chemical, St. Louis, MO) every 3 minutes from a DeVilbiss nebulizer (Model 646, DeVilbiss Health Care, Somerset, PA), controlled with a dosimeter (KoKo dosimeter, Ferraris Respiratory, Louisville, KY). The starting concentration of histamine diphosphate was 2 mg/mL, and the maximum dose used was 16 mg/mL. We measured bronchial responsiveness by recording the subjects' forced expiratory volume in 1 second (FEV₁) on a spirometer Pneumoscreen II (Jaeger, Germany) after each inhaled dose. We expressed and analyzed nonspecific bronchial reactivity as a slope of dose-response curves. We calculated slope as a natural logarithm of percentage of FEV₁ change after last histamine dose divided by a cumulative dose of applied histamine.

Nonspecific Nasal Challenge Test

We assessed nonspecific nasal reactivity by means of a histamine challenge test according to the procedure described by Plavec and colleagues. We sprayed doubling concentrations of histamine diphosphate saline solutions from spray bottles (Lonudal Nasal, Fisons Ltd, West Malling, UK) into both nostrils of each worker every 3 minutes. The starting concentration of histamine diphosphate was 0.5 mg/mL, and the maximum we used was 8 mg/mL. We measured nasal responsiveness by means of total nasal airway resistance (NART) after each inhaled dose. We measured NART on the same spirometer by using the attached facemask and open interruption method.

We expressed and analyzed nonspecific nasal reactivity as a slope of dose-response curves. We calculated slope as a natural logarithm of percentage of NART change after last histamine dose divided by cumulative dose of applied histamine.

Statistical Analysis

We performed statistical analyses by using Statistica for Windows, version 6.0 (StatSoft, Inc., Tulsa, OK). They included descriptive statistics, Student's t test, Pearson's chi-square and the Mann–Whitney test, the Kolmogorov–Smirnov test for non normally distributed data, and correlation, multiple regression, and logistic regression analyses.

RESULTS

Table 2 presents descriptive statistics for all analyzed variables in the examined sample of female office workers divided in 2 groups according to type of building ventilation.

We found a significantly higher SBS Index and more women reporting irritative SBS symptoms in the group from air-conditioned buildings than we did in the group from naturally ventilated buildings. In addition, we found significant differences for work exposure and nasal reactivity. Work exposure was significantly longer and nasal reactivity significantly higher in workers from naturally ventilated buildings than in subjects from air-conditioned buildings (see Table 2).

We compared the prevalence of each SBS-related symptom in women working in air-conditioned buildings with those working in naturally ventilated buildings. We observed statistically significant differences (Pearson's chi-square; \( p < .05 \)) between these groups in the reporting of fatigue (71% vs 47%) and mucous membrane symptoms—that is, throat irritation (43% vs 24%), sneezing (41% vs 23%), and cold (26% vs 12%).

We evaluated the relationships between the SBS symptoms and observed psychosocial, somatic, and environmental variables representing specific biopsychosocial models by means of correlation and multiple regression analyses.

The set of variables entered into the regression model included the following: SBS Index, as a dependent variable, and a block of 15 independent variables. We entered all independent variables into the analysis in a single step. We entered age, duration of working experience, and smoking behavior to control for their possible relations with somatic or psychosocial variables. We entered 6 psychosocial variables into the model: the Cornell Index, subjective estimates of quality of life in 4 domains (WHOQOL D1–D4), and stressful life events (SRSS). We entered 5 somatic variables:
nonspecific bronchoprovocation test (NBPT), nonspecific nasal provocation test (NNPT), skin reactivity to histamine (SPT histamine) and inhalatory allergens (positive SPT), and total serum IgE. We entered building ventilation type as the environmental characteristic. Out of predictor variables included in the regression model, 3 were dichotomous: smoking behavior (nonsmoker vs smoker), SPT to 14 tested allergens (negative vs positive to at least 1 tested allergen), and building ventilation type (natural ventilation vs air-conditioning).

We used the Kolmogorov-Smirnov D test to test normality of distributions in variables to be entered into the multiple regression analysis. We used logarithmic transformations to correct nonnormally distributed data in working experience, total IgE, and SPT to histamine.

Table 3 presents the Pearson product-moment correlation coefficients between the SBS Index and factors that were supposed to be related to SBS. Statistically significant bi-variate correlations were revealed between the results on the SBS Index and 3 predictor variables: Cornell Index, the WHOQOL-D1 scale of subjective quality of life in the domain of physical health, and the type of building ventilation. These results suggested that individuals who exhibited higher levels of neuroticism, those who estimated the quality of their physical health to be lower, and individuals working in air-conditioned offices were more likely to report a higher incidence of SBS complaints than were individuals who exhibited lower levels of neuroticism, those who estimated their physical health to be higher, and those who worked in naturally ventilated offices. According to the results of the multiple regression analysis (see Table 3), the hypothesized model accounted for 15% of the variance in the obtained scores for SBS.

Standardized betas presented in Table 3 indicated that emotional stability (Cornell Index), subjective quality of physical health, and type of building ventilation remained significant predictors of SBS ($p < .05$) after adjustment for other variables. In addition, subjective quality of psychological health exhibited a suppressor effect; in other words, it contributed to the prediction when added to a model because of its association with other independent variables, although it has no relationship with the SBS syndrome on its own. The results shown in Table 3 did not support the hypothesis that any of the analyzed somatic factors would affect reported SBS symptoms.

Furthermore, we checked whether psychological and somatic variables have different role in predicting reports of local irritative symptoms (eye, throat, nose, and skin irritation; cough, sneezing, and cold) than they do in reports of general symptoms (headache, fatigue, trouble in concentration). For this purpose, we tested 2 separate logistic regression models for prediction of local irritative symptoms as well as for prediction of general symptoms. Predictors used in both models were age, duration of work exposure, smoking behavior, and building ventilation type. In addition to these common predictors, 1 model assessed the influence of psychosocial variables, and the other the influence of somatic variables. Only logistic regression models including psychosocial predictors proved to be significant (see Tables 4 and 5), whereas models including somatic factors were not statistically significant, either for reports of general SBS symptoms ($n = 151$; pseudo $R^2 = .0334$; $p = .824$) or local SBS symptoms ($n = 151$; pseudo $R^2 = .0499$; $p = .696$). The odds of reporting at least 1 general SBS symptom increase with a higher neuroticism score on the Cornell Index (odds ratio [OR] = 1.09, 95% confidence interval [CI] = 1.02-1.17, $p = .013$), and a lower subjective physical health score on the WHOQOL-D1 (OR = 0.70, 95% CI = 0.52-0.95, $p = .022$), with other variables controlled for in the model (see Table 4). Similarly, the odds of reporting at least 1 local irritative SBS symptom increase with a higher neuroticism score on the Cornell Index (OR = 1.09, 95% CI = 1.00-1.18, $p = .047$; see Table 5).
.stereotype differences in susceptibility to SBS symptoms may be explained by diverse work patterns and work roles of men and women, different social roles outside the work, and different personality traits and physiological characteristics. It has been well documented that women have higher scores on neuroticism measures across cultures, which in turn may contribute to their susceptibility to SBS symptoms.  

Among analyzed environmental (air-conditioned vs naturally ventilated workplaces), somatic (nonspecific nasal, bronchial, and skin reactivity, positive SPT to inhalatory allergens, and total IgE level as atopy measures), and psychosocial factors (level of neuroticism, subjective estimates of quality in different domains of life, stressful life events), we found air conditioning and psychological factors as independent predictors of SBS symptoms. In addition, separate analyses of psychological and somatic variables point only to psychological factors as predictors of general and local SBS symptoms, whereas somatic variables failed to predict reports of SBS symptoms. 

Correlations of SBS symptoms with self-reported atopy have often been reported, but results on the relation to markers did not differ considerably. The mean value of the SBS Index (symptoms’ score) was higher in women working in air-conditioned buildings than those working in naturally ventilated buildings, mainly as the consequence of statistically significant differences between these groups in reporting fatigue and mucous membrane symptoms (eye irritation, throat irritation, sneezing, and colds).

These findings are in line with the results from other indoor climate studies using similar SBS questions. The investigations by the National Institute for Occupational Safety and Health in 80 buildings showed an increased relative risk of having multiple irritative symptoms in the presence of maintenance deficiencies of the air-conditioning system. Although a strict comparison of our results with those reported in other studies is not possible because of the use of different methodologies, the observed prevalence of symptoms is generally in a similar range. The available data suggest that air-conditioning is associated with a significant increase in the prevalence of 1 or more SBS symptoms that cannot be related to any abnormality in the indoor environment, and our results confirm these findings. At the time of the study, involved buildings were not considered “sick buildings,” and indoor environmental data on air temperature, humidity, and total dust exposure, which were collected from authorized companies, were within permitted values.

Insufficient characterization of individual exposures to pollutants or other types of poor environmental conditions reduces the ability of researchers to identify associations between symptom prevalences and environmental parameters. For a better determination of etiologic factors, more attention should be paid to improved measurements of occupants’ exposures to pollutants and environmental conditions.

Women usually report work-related and environmental symptoms more often than do men, which may explain the relatively high frequencies of complaints in our sample. Sex-based differences in susceptibility to SBS symptoms may be explained by diverse work patterns and work roles of men and women, different social roles outside the work, and different personality traits and physiological characteristics. It has been well documented that women have higher scores on neuroticism measures across cultures, which in turn may contribute to their susceptibility to SBS symptoms.

COMMENT

In this study we aimed to explore the concurrent relation of environmental, somatic, and psychological factors with reported SBS symptoms in female office workers. The main contribution of this investigation is a careful assessment of occupants’ personal factors, atopic diathesis, and psychological variables, by means of objective methods and validated scales, and the attempt to determine the role of mentioned factors in modifying SBS discomfort and medical symptoms in relation to building occupancy.

Two groups of occupants were similar with respect to age, smoking habit, and psychosocial variables. The atopy markers did not differ considerably. The mean value of the SBS Index (symptoms’ score) was higher in women working in air-conditioned buildings than those working in naturally ventilated buildings, mainly as the consequence of statistically significant differences between these groups in reporting fatigue and mucous membrane symptoms (eye irritation, throat irritation, sneezing, and colds).

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between the SBS and objectively established atopy are controversial. Muzzi and colleagues failed to show a link of SBS with atopy defined as positive skin prick test to common inhalatory allergens. In contrast, Bjornsson and colleagues reported atopy as an independent risk factor for scoring at least 1 SBS symptom. In this study, we used 2 criteria for atopy: positive SPT to common inhalatory allergens based on the comparison with negative control solution, and level of total IgE. According to both criteria, we were not able to confirm that atopy can be considered as a predictor of SBS symptoms, general or irritative. This finding was strengthened by results that failed to find a connection between nonspecific nasal, skin, and bronchial reactivity with SBS. Studies on the relationship between objectively measured airway reactivity and SBS symptoms have been rare so far, and, to our knowledge, this is the first study separately assessing nonspecific upper- and lower-airway reactivity, and nonspecific skin reactivity with regard to SBS. A previously evaluated relation of bronchial reactivity and SBS revealed controversial results again, with 1 study showing a connection of bronchial reactivity with irritative pharyngeal symptoms that was not confirmed in other. Keep in mind that Bjornsson and colleagues, who pointed to somatic predictors of SBS, performed their study on the general population, whereas Muzzi and colleagues performed theirs on a working population and found that psychosocial factors significantly contribute to the expression of work-related SBS symptoms, which is in accordance with our results.

It is difficult to consider occupant discomfort and symptoms in a work environment without acknowledging that all symptoms and diseases have a psychological component. The psychosocial processes may act directly as stressors, causing symptoms through psychophysiological mechanisms. Furthermore, they may render the individual more sensitive to normally tolerated physical and chemical factors in the environment. In the present study, the role of stressful life events in predicting SBS symptoms was examined and no relation was found between exposure to life events in the previous year and the SBS symptoms, either in the overall model or in the separate models of irritative and more general symptoms.

The Cornell Index variable presents the value on the personality trait continuum from neuroticism to emotional stability. Keeping in mind that personality is stable set of intrapsychic characteristics and tendencies, we can speculate on its direct influence on work environment perception, rather than vice versa. Although the vast majority of actual Cornell Index scores fall into the range of normal results, we expected that a lower emotional stability dimension would provoke less satisfaction with the actual indoor work environment, pointing to the fact that personality characteristics are not only constant over time but that they are strong behavior determinants.

The relationship between the Cornell Index and SBS Index and SBS symptoms in our model indicates the independent contribution of the relatively stable personality trait of neuroticism to reports of symptoms attributed to SBS. Nevertheless, we also found an association between WHOQOL-D1 and the SBS Index and SBS general symptoms, which indicates that the perceived state of overall physical health in a relatively short period contributes additionally and independently of other factors to reports of SBS symptoms. Because both the subjective estimates of physical health and reports of SBS symptoms are given for the same period of time, it is not possible to separate the effect of perceived physical health on the reports of SBS symptoms from the reverse effect of reported SBS symptoms on the perception of overall physical health.

Conclusion

Our findings, in conjunction with those reported previously, indicate that female office workers commonly report SBS-related health symptoms, especially those women who work in air-conditioned office buildings. Neuroticism and subjectively estimated physical health as psychological factors, and air-conditioning as an environmental factor, seem to be associated with the reporting of the SBS symptoms in women, confirming the results of earlier studies on the multifactorial background of work-related SBS. The associations between symptoms and psychological variables can be the basis for more detailed hypotheses regarding the causes of symptoms and a set of questions about work-related SBS, suggesting the additional need for a distinction between SBS and "sick workplace syndrome."

References
