Evaluation of the relationship between sick building syndrome complaints among hospital employees and indoor environmental quality

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ABSTRACT

Background: Sick building syndrome (SBS) is defined as a condition occurring in people who live or work in a modern building and who suffer from complaints such as headache, fatigue, lack of concentration, and irritation of the skin and mucous membranes. Objectives: The aim of this study was to examine the complaints associated with SBS in the employees of our hospital and evaluate the relationship between the characteristics of the work environment and the complaints of SBS. Methods: 890 workers participated in the study. The complaints of the participants were rated and the sum of all complaints was recorded as the Total Complaint Score (TCS). The mean TCS of the participants was compared according to demographic characteristics and work environment characteristics. Results: The most common complaints among the employees were fatigue (40%), and general muscle and joint pain (31.4%). There was a statistically significant difference in TCS according to the position (p < 0.001). The mean TCS was significantly higher in females [13 (0–81)] than in males [6 (0–59)] (p < 0.001). The mean TCS increased with the presence of odor, new wall paint, the presence of fungus/mold on walls, and the presence of rotting/mold smell (p < 0.001, for all). TCS positively correlated with stress level, social relationship, noise level, comfort, cleanliness, number of employees in the same room, presence of odor, new wall paint, presence of rotting/mold, and use of chemical materials for cleaning in the room (p < 0.001, for all), and negatively correlated with room size and number of windows (p = 0.006, p < 0.001, respectively). Discussion: The present study found that the female gender, a high level of education, a high level of stress, a low level of social relationships and work environment characteristics were associated with the complaints of SBS among the employees. Accordingly, we believe that hospital management should be informed in order for the managers to take precautions and make new regulations.

INTRODUCTION

Sick building syndrome (SBS) is defined as a condition that occurs in people living or working in a modern building and suffering from complaints such as headache, fatigue, lack of concentration, and irritation of the skin and mucous membranes (1). The negative effects experienced by the residents of a building on their health and well-being are related to the time spent in that building. However, a specific disease or cause cannot be identified. The complaints may be related to a specific room or involve a certain region or the entire building (2). The most important feature of SBS, which was defined following the studies conducted by the World Health Organization in Northern Europe...
and the United States of America (USA), is that the complaints lessen when the affected person leaves the building (3). The complaints occurring in the employees can be associated with themselves, the materials or the technologies they use, or be caused by their duties in the buildings (e.g., stress) or a characteristic of the building (4). Factors that may cause SBS have been classified as follows: biological factors (molds, bacteria, microbial volatile organic compounds, house dust); chemical factors (construction and household products, formaldehyde, phthalates, man-made mineral fibers, volatile organic compounds, odors, environmental tobacco smoke, other indoor air pollutants); physical factors (environmental parameters of thermal comfort, parameters related to building ventilation, noise, vibrations, daylight, electromagnetic fields, ions, ergonomics, universal design); psychosocial factors (occupational stress, social status, loneliness, helplessness, work organization, communication, supervision); individual factors (gender, individual characteristics, health status); and other (location, geopathogenic zones; building characteristics, ownership, presence of insects, rodents, use of pesticides, disinfection, raticides) (5).

SBS is an issue of increasing importance among office workers worldwide (6, 7) and the most important cause of job loss and low performance (8). Good indoor air quality, favorable environmental factors, ergonomic features and the thermal comfort of the building improve employee satisfaction and comfort, and thereby increase productivity and reduce job loss (1). The main complaints of SBS are burning and watery eyes, nasal congestion, runny nose and sneezing, dry throat, fatigue, lethargy, headache, and occasionally asthma (4). Indoor air quality problems and insufficient ventilation in the working area can cause SBS and aggravate the complaints. In order to evaluate the indoor air quality as ‘good’, the temperature must be between 19 and 23°C, and the relative humidity rate must be 40–60%. Recently, there has been an increase in demand for buildings impervious to air, heat and moisture, in which novel insulation materials are used to save energy. However, this form of insulation has increased the possibility of keeping chemical compounds indoors (9).

Our hospital consists of three buildings, and the indoor environment measurements are carried out every year on a regular basis as required by law. The number of particles, noise level, temperature and relative humidity are all within legally permissible limits (10). The present study aims to examine the complaints of SBS in the employees of our hospital and evaluate the relationship between the characteristics of the work environment and SBS complaints.

**METHODS**

The study was conducted in accordance with the recommendations of the Declaration of Helsinki and was approved by the Local Ethics Committee (2011-KAEK-25 2018/06-09).

**Participants:** All staff working in our hospital (No. = 1282) were evaluated. Those who worked in the hospital less than one month were excluded from the study (no. = 42, 3.3%), and all other employees were asked to complete the “Sick Building Syndrome Questionnaire” (no. = 1240, 96.7%). The questionnaire forms of 928 employees (74.8% of those who were asked to complete the questionnaire) who agreed to participate in the study were evaluated, and 38 of these employees (4.1% of those who agreed to participate in the questionnaire) were excluded from the study due to missing personal information or unanswered questions. The study continued with 890 questionnaires completed by the participants.

**The Sick Building Syndrome Questionnaire:** The study used the questionnaire MM 040 NA Hospital, which was developed by Andersson et al. (11) and the Turkish validation of which was conducted by Arikan et al. (1), and several items were added to the questionnaire to examine the physical characteristics of the work environment. The questionnaire consists of three sections. In the first section, the demographic data of the participants were evaluated. The questions included active and passive smoking, hours of working in the building, daily working hours, stress levels, social relationships with colleagues, hours of working with computers, and the noise level, comfort and cleanliness of the work environment. The second section inquired...
29 complaints such as red-dry eye, nasal congestion, flu, dry throat, fatigue, tendency to sleep, headache, and dry-red skin on a 4-point scale (Never: 0, Sometimes: 1, Often: 2, Always: 3 points). The last section inquired the factors that may have caused these complaints in the work environment. These factors included the surface area of the work environment and the number of people working in the same environment, the number of windows, whether the windows are facing the main street, ventilation systems, filters, odor, mold, new wall paint in the room as well as the use of pesticides, the presence of new furniture, use of chemicals for cleaning, smoking status in the room, floor materials, and the number of computers.

**Total Complaint Score (TCS):** The volunteers evaluated each complaint as “none, rarely (once a week or less frequent), frequently (2-3 times a week) and constantly (at least 5 times a week). The scores were assessed as follows: none: 0, rarely: 1, frequently: 2, constantly: 3. The score obtained by the individual from all complaints was recorded as TCS.

**Statistics:** Statistical analyses were performed with IBM SPSS ver. 23.0 (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0 Armonk, NY: IBM Corp.). The data was examined by the Shapiro Wilk test whether or not it presents normal distribution. Descriptive statistics were given as median (minimum-maximum) values for continuous variables and frequency with percentages for categorical variables. The continuous variables were compared using the Mann Whitney-U test. Spearman correlation coefficient was calculated for correlations between variables. Multiple regression analysis was performed for effects of the working environment variables on TCS values. p<0.05 was considered as significance levels.

### Results

The study included 890 hospital employees. The demographic data, work time, and pre-existing diseases of the participants and their rates are presented in Table 1. The assessment of comfort, cleanliness and noise level in the work environment shown in Table 2.

When the stress level of hospital staff was examined, 28.8% (no. = 254) had extreme stress, 30.9% had much stress (no. = 272), 32% (no. = 282) had moderate stress, 4.9% (no. = 43) had mild stress, and 3.3% (no. = 29) had no stress. Among the participants, 85% (no. = 751) had good or very good social relationships and 74.7% (no. = 660) were working with computers. The rate of those working in a room facing the main street was 11.2% (no. = 84), while 89.4% (no. = 648) were working in a room with air conditioning and central heating system. The characteristics of the workrooms are presented in Table 3.

The most common complaints among the employees were fatigue (40%), generalized muscle

### Table 1 - Demographic data, working times and current diseases of volunteers

| Age (years) | 37 (20-68) |
| Gender (male) | 272 (30.6) |
| Smoking | 288 (32.4) |
| Working time (years) | 11 (0-43) |
| Working time in the building (years) | 6 (0-18) |
| Working time in the room (years) | 3 (0-18) |
| Daily working time in the room (hours) | 8 (0-24) |
| Daily working time indoors (hours) | 8 (0-24) |
| Rhinitis | 179 (20.1) |
| Chronic pharyngitis | 91 (10.2) |
| Chronic sinusitis | 128 (14.4) |
| Asthma | 64 (32.4) |

Descriptive statistics were given as median (minimum-maximum) or frequency with percentage

### Table 2 - Evaluation of the working environment

| | Excellent (%) | Well (%) | Middle (%) | Insufficient (%) | Very inadequate (%) |
|---|---|---|---|---|---|
| Comfort no. (%) | 17 (1.9) | 138 (15.6) | 374 (42.4) | 256 (29) | 98 (11.1) |
| Cleaning no. (%) | 65 (7.4) | 286 (32.4) | 346 (39.2) | 142 (16.1) | 43 (4.9) |
| Noise level no. (%) | 32 (3.2) | 154 (17.4) | 310 (35) | 233 (26.3) | 156 (17.6) |
and joint pain (31.4%), burning eyes (28.3%), dry throat (27.6%), headache (26%), dry skin (26%) and watery eyes (23%) (Figure 1). The mean TCS was highest among the nurses [15 (0–81)]. This was followed by technicians [10 (0–61)], office workers [9 (0–73)], secretaries [7.5 (0–59)], physicians [7.5 (0–51)], cleaning personnel [3 (0–23)], and security personnel [2.5 (0–44)] in respective order. 

TTT significantly varied depending on the position (p < 0.001). Nurses had significantly higher TCS than physicians, office workers, secretaries, technicians, security and cleaning personnel (p = 0.006, p < 0.001, p = 0.005, p = 0.001, and p = 0.001, respectively). There was no significant difference between technicians and office workers, and between technicians and physicians (p = 0.26, p = 0.39, respectively). There was no significant difference between secretaries and security personnel, secretaries and cleaning personnel, and cleaning and security personnel (p = 0.15, p = 0.11, p = 0.81, respectively). The mean TCS was significantly higher in females [13 (0–81)] than in males [6 (0–59)] (p < 0.001). There was no significant difference in mean TCS according to marital status (p = 0.33). The mean TCS differed significantly depending on the educational level (p <0.001). The mean TCS increased with increasing level of education (p < 0.001). The mean TCSs were compared according to the work environment characteristics (Table 4). The mean TCS positively correlated with gender, educational level, stress level, social relationship, noise level, comfort level, cleanliness, the number of employees in the room, the number of windows, the presence of odor, new wall paint, the presence of rotting/mold, the use of cleaning chemicals in the room (p < 0.001, for all) and room size (p = 0.006).

When the variables in the regression model are examined, the variable new wall paint was found to have the greatest effect within the model. The least contributory variable was daily cleaning in the room. In the presence of variables in the model, an increase is observed in the TCS score (Table 5).

**Discussion**

This study is a comprehensive study that compares the frequency of SBS complaints among hospital staff according to environmental characteristics and working conditions such as educational status, level of stress, level of social relationships, level of comfort, cleanliness, number of employees in the room, room size, number of windows, presence of odor, presence of new wall paint, presence of rotting/mold, and frequent use of chemicals for cleaning in the room.

The present study found that the female gender, new wall paint, the presence of odor, the presence of fungus and mold on the wall, and daily cleaning of the room were associated with the complaints of SBS in the work environment of our hospital. Previous studies have examined topics such as the frequency of SBS complaints in non-hospital buildings (4), the relationship between environmental measurements and SBS (9, 12), or the comparison of the frequency of SBS complaints and environmental measurements between departments (5).

Daily cleaning using chemical substances, the presence of new wall paint, the decrease in room size and the number of windows increased TCS significantly. We could not identify any study examining the relationship between SBS complaints and the room size and number of windows, new wall paint...
Figure 1 - Rates of employee complaints
Table 4 - Comparison of variables of the working environment by the TCS average

| Variable                        | TCS, median (min-max) | p Value* |
|---------------------------------|-----------------------|---------|
| Gender                          |                       |         |
| Female                          | 13 (0-81)             | <0.001* |
| Male                            | 6 (0-59)              |         |
| Room Type                       |                       |         |
| Service room                    | 11 (0-81)             | 0.510   |
| Study room                      | 11 (0-72)             |         |
| Room overlooking the main street|                       |         |
| (+)                             | 9 (0-51)              | 0.297   |
| (-)                             | 11 (0-81)             |         |
| Ventilation                     |                       |         |
| (+)                             | 11 (0-81)             | 0.410   |
| (-)                             | 12 (0-59)             |         |
| Filter cleaning                 |                       |         |
| (+)                             | 11 (0-81)             | 0.237   |
| (-)                             | 12.5 (0-73)           |         |
| Presence of odor                |                       |         |
| (+)                             | 16 (0-73)             | <0.001* |
| (-)                             | 9 (0-81)              |         |
| Presence of mist                |                       |         |
| (+)                             | 16 (0-67)             | 0.139   |
| (-)                             | 11 (0-81)             |         |
| New wall paint                  |                       |         |
| (+)                             | 17 (0-81)             | <0.001* |
| (-)                             | 10 (0-73)             |         |
| Fungus and mold on the wall     |                       |         |
| (+)                             | 22 (0-65)             | <0.001* |
| (-)                             | 11 (0-81)             |         |
| Rotten and mold odor            |                       |         |
| (+)                             | 22.5 (0-73)           | <0.001* |
| (-)                             | 11 (0-81)             |         |
| Room spray                      |                       |         |
| (+)                             | 9 (0-81)              | 0.159   |
| (-)                             | 12 (0-73)             |         |
| Daily cleaning in the room      |                       |         |
| (+)                             | 11 (0-81)             | <0.001* |
| (-)                             | 8 (0-51)              |         |
| New furniture in the room       |                       |         |
| (+)                             | 11 (0-81)             | 0.459   |
| (-)                             | 11 (0-73)             |         |
| Smoking in the room             |                       |         |
| (+)                             | 14 (0-47)             | 0.403   |
| (-)                             | 11 (0-81)             |         |
| Recent isolation in the room    |                       |         |
| (+)                             | 11 (0-54)             | 0.830   |
| (-)                             | 11 (0-81)             |         |
| Insecticide application in the room |                   |         |
| (+)                             | 11 (0-81)             | 0.519   |
| (-)                             | 11 (0-72)             |         |

TCS: Total Complaint Score, #Mann Whitney-U Test, *p<0.05
employees in Taiwan reported that nasal (66%) and eye complaints (53%) were the most frequent complaints. The authors also found dry facial skin in 33% and fatigue in 30% (27). In a study by Quoc et al. involving 207 hospital employees, the most frequent complaints were fatigue, headache, dizziness, cough and dry throat in respective order (20). Also in the present study, the most common complaint was fatigue (40%). This was followed by generalized muscle and joint pain (31.4%), burning eyes (28.3%), dry throat (27.6%), headache (26%), dry skin (26%) and watery eyes (23%). Building characteristics and working conditions can cause different complaints in different work areas.

TCS increased significantly with increasing level of education. On the other hand, a study by Karvala et al. examined 4,941 people from general population found that low level of education was associated with SBS complaints, especially in women (21). Since the participants of the present study were healthcare workers, we believe that they may have slightly better awareness of the effects of work environment conditions on health. The authors consider that people with higher level of education in the present study may have reported higher number of complaints.

Menteşe et al. indicated that dermatological complaints increased with increasing number of employees working in the same room (12). The present study found a correlation between the number of employees in the same room and TCS. We found that TCS significantly increased as the participants’ complaints about the noise level increased. Rashid et al. reported an increased risk of SBS with an increase in the noise level measurements (28).

Arikan et al. (1) and Akova et al. (29) also agreed with this finding and indicated that the risk was 1.2 and 3.11 times higher, respectively. In the present study, we found that the presence of a rotting smell and mold in the environment significantly increased TCS. This finding was in support of previous studies. However, hospital settings were not examined in any of these studies (4, 30–32).

The limitation of the present study was conducted based on the subjective questionnaire responses of the participants. The participants who reported complaints did not undergo physical examination. Another limitation is the absence of examination of the differences between departments. Furthermore, environmental measurements were not included in the study. The periodic measurements of noise, moisture, temperature, and gas and particles in ambient air, which are a legal obligation, are carried out every year in our hospital and are found to be within normal limits.

**Conclusion**

The present study found that female gender, a high level of education, a high level of stress, a low level of social relationships, a high level of noise, a decreased level of comfort, a large number of employees in the room, room size, the number of windows, the presence of odor, the presence of new wall paint, the presence of rotting/mold, and the frequent use of chemicals for cleaning in the room were associated with SBS complaints among individuals working in the hospital setting. We believe that hospital management should be informed in order for the managements to take measures and

| Table 5 - Multiple linear regression analysis results for TCS |
|-----------------------------------------------|
| **Unstandardized Coefficients B** | **Standardized Coefficients Beta** | **t** | **p** |
|-----------------------------------------------|
| Constant 4.741 | 3.050 | 0.002 | |
| Gender (Female) 5.150 | 0.164 | 4.522 | <0.001 |
| Presence of odor 4.884 | 0.160 | 4.420 | <0.001 |
| New wall paint 6.487 | 0.192 | 5.122 | <0.001 |
| Fungus and mold on the wall 4.486 | 0.079 | 2.128 | 0.034 |
| Daily cleaning in the room 3.523 | 0.083 | 2.302 | 0.022 |

TCS: Total Complaint Score
make new regulations to improve indoor quality, and healthcare workers should be made aware of the relationship between the characteristics of their work environment and SBS. It would also appear to be important to arrange work environments in the light of these findings in the new hospital buildings in order to achieve high levels of employee productivity and to protect employee health.

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