ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 08, Issue, 06, pp.21199-21202, June, 2018

ORIGINAL RESEARCH ARTICLE OPEN ACCESS

THE RELATIONSHIP BETWEEN SICK BUILDING SYNDROME AND ENVIRONMENTAL MEASUREMENTS IN INTENSIVE CARE AND OPERATING ROOM; A PILOT STUDY

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ARTICLE INFO

Article History:
Received 28th March, 2018
Received in revised form
13th April, 2018
Accepted 25th May, 2018
Published online 30th June, 2018

Key Words:
Occupational health,
Headache, Eye witness,
Eye redness,
Nasal obstruction.

ABSTRACT

Objective: Acute health problems and illnesses that a person in a certain building lives without a specific illness or cause are defined as Sick Building Syndrome (SBS). The purpose of this study is to investigate the complaints of volunteers working in the 3rd stage general intensive care unit and the operating room and the possible causes of these complaints.
Method: Volunteers working in the tertiary intensive care unit (ICU) and in the operating room (OR) were taken into the study. Participants were asked to respond to a questionnaire. Building Symptom Index was calculated and compared in ICU and OR. The correlation between ambient measurements and employee complaints was examined.
Results: Seventy six volunteers participated. Twenty-six participants (34.2%) were male. The most common complaints are fatigue and headache; the most common reasons for complaints were noise and heat. BSI=5.3±2 was found. In OR, eye witness-redness and nasal obstruction complaints were more common and BSI was found higher. Ocular complaints related to working in OR, sound and temperature, humidity, room volume per employee, air exchange rate and particle count.
Conclusion: In hospitals, indoor physical conditions can affect health professionals' work efficiency and health in a bad way.

Citation: Dülger Seyhan and Sayan H. Erkani. 2018. "The relationship between sick building syndrome and environmental measurements in intensive care and operating room; a pilot study", *International Journal of Development Research*, 8, (06), 21199-21202.

INTRODUCTION

Nowadays, indoor environments are becoming more important in relation to people passing much more time in enclosed spaces (Lu *et al*., 2018). In enclosed environments, heat, light, noise and ambient air have implications for the health, comfort and productivity of the people living there (Vaizoğlu *et al*., 2000). Sick building syndrome (HBS) is defined as acute health problems and illnesses that are experienced by residents of buildings with indoor problems, related to the time they spend in the building despite the fact that a specific disease or cause can not be determined (Zhang *et al*., 2012).

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The main symptoms are burning and irritation in the eyes, nasal obstruction and discharge, sneezing, dryness in the throat, lethargy, headache and sometimes asthma. Headache is usually a non-pulsating, blunt character on both sides of the forehead and behind the eyes (Popay *et al*., 1993). These complaints may be related to specific indoor working environments, and psychosocial status and personal factors (Lu *et al*., 2018). It is thought that HBS is the most important cause of job loss and poor performance in employees (Jafari *et al*., 2015). Incorrect air quality, insufficient ventilation, biological agents, construction materials, noise, lighting may cause HBS (Popay *et al*., 1993). The temperature should be between 19-23°C and the relative humidity should be 40-60% (Çobanoğlu *et al*., 2006). The most important factors affecting indoor physical conditions are temperature, humidity, lighting and noise (Hayta *et al*., 2007).

Ambient heat of indoor space is one of the most important factors affecting employee productivity (Lan *et al*., 2009). Excessive warmth causes boredom, nervousness, carelessness, increased mistakes, decreased skills, increased work accidents, deterioration of water and electrolyte balance in the body, impaired blood circulation and fatigue. The cold work environment also reduces the ability to do fine work. Depending on the fact that the indoor area is not in the proper temperature, job accidents increase the risk, job loss (Hayta *et al*., 2007). Below 35% of the humidity level in the indoor environment causes eyes to dry, nasal obstruction, skin symptoms and tendency to infections. High moisture level, on the other hand, provides the basis for the reproduction of microorganisms such as fungi. Also, as the humidity level increases, the temperature felt increases (Güler *et al*., 2006).
The light level in the working environment is also one of the parameters affecting comfort conditions. Good lighting is important for eye strain and visual acuity. More efficient working, protection from the accident, psychological conditions of the employees, lighting. Symptoms such as tiredness, redness, dryness and headache may occur in the eyes as a result of inadequate lighting (Güler Ç, 2004). Noise is an environmental factor that can cause adverse consequences. In over-noisy environment, people become restless, verbal communication is blocked, working activity is reduced, behavioral disorders can occur, loss of hearing can occur (Güler *et al*., 2006). Health workers spend more hours in hospital buildings than in a normal office worker. Intensive care and operating rooms can also be considered as specialty units in terms of aeration, heat, sound and humidity in the hospital. The aim of this study is to compare the complaints of volunteers working in the 3rd stage general intensive care unit and the operating room that may be connected to HBS, and the possible causes of these complaints.

MATERIALS AND METODS

This pilot study is a prospective, cross-sectional, controlled survey study. Signed permission form was taken from all volunteers who participated in the work and worked in accordance with the Helsinki Declaration. Our patients were included in the study to volunteer from 3rd baseline general intensive care unit (ICU) and operating rooms (OPR). Employees who did not want to answer the questionnaires were excluded from the study. Participants were asked to respond to a questionnaire planned for HBS.

Survey: Based on the validity study conducted by Burge *et al* (1987). In the first part, the demographic data of the participants were evaluated. They were asked about the area of the environment they were working on and how many people they worked in the same environment. Afterwards, complaints of redness and dryness in the eyes, nasal congestion, colds, throat instability, fatigue, dizziness, headache, dryness and redness of the skin were questioned. In the last part, these complaints were examined which factors in the business environment could be causing and what the participants did to get these complaints. The volunteer's survey responses were evaluated separately for each of the 2 environments and compared with each other.

Evaluated Parameters

Building Symptom Index (BSI): The number of symptoms per participant was calculated as mean ± standard deviation (Burge *et al*., 1987).

Ambient Air Change Rate, Heat, Sound, Humidity and Particle Count Measurements: Observations of the Occupational Hygiene Measurement and Analysis, which are mandatory for hospitals every year, were taken from the year 2017 report. This report is prepared by an Environmental Laboratory certified by the Turkish Accreditation Agency.

Statistical analysis

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) version 23 program. The distribution of the groups was examined by the Kolmogorov-Smirnov test. Numeric values are median (minimum-maximum); categorical information was evaluated with percentage ratios. Mann Whitney-U test for comparison of median values of groups; Pearson Chi-square test and Fisher test were used to compare the ratios. The correlations were assessed by Spearman correlation test. Values of $P < 0.05$ were considered to be statistically different.

RESULTS

Seventy six volunteers participated our study from ICU and OPR employees. Fifty (65.8%) of the employees were female and 26 (34.2%) were male. Age median values were 35 (22-49) years. The working time in our hospital is 5 (0.6-17) years. They were working on 6 (5-7) days of the week. In the same environment, 5 (4-20) people worked together. In the working environment, there were 27.6 (12-54.8) m^3 rooms per person. In ambient measurements the sound was 63.9 (63.37-65.43) dBA, the temperature was 24.7 (19.6-24.7) ^{0}C, the humidity was 40.8% (40.8-44.1), the air exchange rate 36.1 (16.7-98.5) (m^3/h) /m^2, and the number of particles (for 0.5 micron) was 117363.8 (28313.5-2948069.2). 71.1% of the employees (n=54) thought that ventilation was inadequate in the environment which they were working. Those who recovered at home were 73.7% (n = 56). In Table 1, employees are given complaints and working environment conditions that they think cause these complaints.

Table 1. Employee complaints, their causes and ways of improving complaints

n=76		Percentage rate (%)
Complaints	Eye witness-redness	46.1
	Nasal obstruction	75.0
	Rhinit	53.9
	Throat foundation	65.8
	Fatigue	88.2
	Lethargy	64.5
	Headache	80.3
	Dry-redness on the skin	53.9
People who improve complaints at home		73.7
What do you think the cause of your complaints might be?	Heat (hot or cold)	72.4
	Light or dark	50.0
	Noise	82.9
	Odor (disinfectant, waste)	31.6
What to do to improve complaints are you doing?	Move away from work area	29.4
	Move away from the building	11.8
	Use drugs	41.2
	Noting	17.6

The most common complaints are fatigue and headache; the most frequent noise and heat disturbances were felt in the working environment. BSI = 5.3 ± 2 was found.

Table 2. Comparison of ICU and OPR data

		ICU (n=36)	OPR (n=40)	p Values
Age[a]		30 (22-43)	38(25-49)	0.007*[1]
Gender (male)[b]		41.2 (7)	27.5 (11)	0.194[2]
Study time at hospital (year)[a]		4 (1.5-11)	7 (1-17)	0.006*[1]
Weekly work day [a]		6 (3-7)	6 (5-7)	0.665[1]
Work area per person (m^3/number of people)		34.2 (34.2-54.8)	17.9 (12-32.4)	<0.001*[1]
Particle measurement (for 0,5 ɥ)		651773.2(28313-2948049.2)	101169.8(87429-146829.5)	<0.001*[1]
Air Change Ratio ((m^3/h)/m^2)		32.9 (16.7-35.8)	56,2 (34.8-98.5)	<0.001*[1]
Sound measurement (dBA)[c]		63.37	63.9	0.647[1]
Pressure measurement (kPa)[c]		101.32	101.37	<0.001*[1]
Temperature measurement (°C)[c]		20.2	24.7	<0.001*[1]
Humidity measurement (%)[c]		44.1	40.8	<0.001*[1]
Complaints	Eye witness-redness[b]	47.1 (8)	65 (26)	<0.001*[2]
	Nasal obstruction[b]	64.7 (11)	85 (34)	0.034*[2]
	Rhinit[b]	59.2 (9)	57.5 (23)	0.512[2]
	Throat foundation[b]	47.1 (8)	70 (28)	0.415[2]
	Fatigue	88. (15)	92.5 (37)	0.294[2]
	Lethargy[b]	64.7 (11)	70 (28)	0.289[2]
	Headache[b]	82.4 (14)	80 (32)	0.952[2]
	Dry-redness on the skin[b]	58.8 (10)	55 (22)	0.846[2]
Building symptom index (BSI)		4.7±2.1	5.7±2	0.026*[1]
People who improve complaints at home[b]		75 (27)	72.5 (29)	0.805[2]
Inadequate ventilation[b]		64.7 (11)	72.5 (29)	0.769[2]
What do you think	Heat (hot or cold)[b]	29.4 (5)	82.5 (33)	<0.037*[2]
the cause of your	Light or dark[b]	64.7 (11)	47.5 (19)	0.923[2]
complaints might	Noise[b]	88.2 (15)	82.5 (33)	0.749[2]
be?	Odor (disinfectant, waste) [b]	23.5 (4)	37.5 (15)	0.242[2]
What to do to	Move away from work area[b]	29.4 (3)	2.5 (1)	
improve complaints	Move away from the building[b]	11.8 (2)	12.5 (5)	0.054[2]
are you doing?	Use drugs[b]	41.2 (7)	20 (8)	
	Noting[b]	17.6 (3)	65 (26)	

(ICU: 3rd stage general intensive care unit, OPR: operating room, [a] median (minimum-maximum), [b] percentage (number of persons), [c] environment measurement, [1] Mann Whitney-U test, [2]Q-Square test, *p<0.05)

Table 3. Correlation test of employees' complaints with environment measurements

Spearmancorrelation test		Groups	Noıse	Temperature	Humıdıty	Meter^3 / employees number	Aır change ratıo	Partıcle number
Eyewitness-redness	r	0.401**	-0.309**	0.470**	-0.292*	-0.350**	0.332**	-0.521**
	p	<0.001	0.007	<0.001	0.011	0.002	0.003	<0.001
Nasalobstruction	r	0.243*	-0.025	0.235*	-0.228*	-0.228*	0.178	-0.140
	p	0.034	0.829	0.041	0.048	0.048	0.124	0.228
Rhinit	r	0.075	-0.042	0.083	-0.060	-0.136	0.097	-0.246
	p	0.519	0.717	0.474	0.609	0.242	0.405	0.032
Throatfoundation	r	0.094	0.188	0.029	-0.149	-0.151	0.082	0.047
	p	0.421	0.105	0.802	0.200	0.191	0.480	0.688
Fatigue	r	0.142	-0.106	0.165	-0.104	-0.106	0.090	-0.092
	p	0.222	0.362	0.154	0.371	0.361	0.439	0.429
Lethargy	r	0.122	-0.093	0.143	-0.089	-0.059	0.116	-0.130
	p	0.295	0.424	0.219	0.445	0.615	0.318	0.261
Headache	r	-0.007	-0.029	0.002	0.016	-0.014	0.038	-0.021
	p	0.952	0.804	0.983	0.893	0.903	0.741	0.856
Dry-redness on the skin	r	-0.022	-0.080	0.046	0.003	0.011	-0.051	-0.123
	p	0.849	0.492	0.695	0.977	0.927	0.660	0.288

r = Correlation coefficient, * p <0.05, ** p <0.01

In OR, eye witness-redness and nasal obstruction complaints were more common and BSI was found higher. Comparison of ICU and OPR data is shown in Table 2. Ocular complaints related to working in OPR, sound and temperature, humidity, room volume per employee, air exchange rate and particle count. Nasal obstruction was also correlated with ambient temperature measurement, ambient humidity and room volume per employee. Table 3 provides a correlation between volunteers' complaints and environment measurements.

DISCUSSION

The most important finding of our study is that BSI is statistically significantly higher in OPR employees than in ICU employees.

In a study conducted by Burge *et al*. (1987) on 3845 office workers, the mean BSI was 3.1. In our study, this value was 5.2±2. Altınöz (2017), in their study with 145 hospital employees, BSI was 4.5±2.2 in intensive care unit; They reported 4±2 in the operating room. We have not been able to find a previous study comparing operating room and 3rd floor intensive care unit. However, it can be said that BSI is higher in the operating room and 3rd basin general intensive care unit than our previous studies. Symptoms of eye witness-redness and nasal obstruction were found to be statistically significantly higher than those in the OPR employees. For eye complaints in previous studies; this ratio was 53.5% (Jafari *et al*., 2015), 23.4% (Lu *et al*., 2018), 15.9% (Takaoka, 2016);for nasal obstruction,it was 40.6% (Jafari *et al*., 2015) and 24.2% (Takaoka, 2016, respectively). In our study, the average rate of

eye witness-redness was 65% in OPR and 47.1% in ICU. Nasal obstruction was 85% and 64.7% respectively. The most common complaints in both settings were fatigue, headache and nasal obstruction. Earlier studies also supported our findings. Takaoka *et al*.(2016) found that the most common complaints were fatigue, flu and nasal obstruction. Lim *et al*. (2015) found that the most common complaint was fatigue in college staffs. OPR employees complained more than ICU employees because it was too hot or cold in the working environment. Those who complained of heat in OPR were 82.4% of the employees and 29.4% in ICU. These rates were 54% and 57% respectively in the study of Altınöz (2017). Noise was the most uncomfortable factor in both ICU and OPR. Although the ambient sound measurements made were within normal limits, employees were most often cited as the cause of their complaints. Altınöz (2017) reported 39% of the employees complaining of noise in OPR and57% in ICU. Complaints about eye and nasal obstruction correlated with working in OPR, noise, temperature, humidity, air exchange rate and particle count. There was also an inverse correlation between these complaints and the per worker area. Vaizoğlu *et al*. (2000) reported 20 m^3 of air volume per person and 6 m^3 of patient wards. In our study, 17.9 m^3 in OPR and 34.2 m^3 in ICU were found. There seemed to be enough in the ICU, but there was not enough air volume for OPR employees. We found a correlation between eye and nose complaints and air volume per person, and the high incidence of these complaints in OPR also supported our notion that there was an inadequate working area.

When it was asked to employees what they were doing to improve their complaints, they said that often used drugs or did nothing. Moving away from the building or the area they were working on were less common. It is clear that these measures are not clear solutions to avoid SBS. In SBS protection, it is important to increase air distribution speed, ventilation and heating systems to comply with the standards. The use of frosted glass, windows that allow natural light entry, terrace gardens and indoor plants are recommended. It is important for employees to change the physical conditions of the environment which they are in, and if they can not do so, make settings for heat, light, sound and ventilation by the units to which they can easily communicate (Altınöz, 2017). The relatively low number of participants, the inability to reach the ambient radiation-radon-magnetic field-electrical field measurements, and the inability to assess the relationship of current employee complaints with work stress, burnout syndrome and emotional states are limitations of our study.

Conclusion

The indoor physical conditions in hospitals may affect the health care employees' work efficiency and health in the worst way. It is important to consider the SBS findings and improve the indoor conditions in hospital buildings especially in units that have long working hours such as ICU and OPR.

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