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Prevalence of sick building syndrome in hospital staff and its relationship with indoor environmental quality

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ABSTRACT

The aim of this study was to determine the prevalence of sick building syndrome (SBS), and its relationship with indoor environmental quality in hospital settings. This cross-sectional study was carried out on 300 hospital staff in Sivas. MM 040 NA Hospital questionnaire was applied. In the hospital indoor environments, air quality (carbon monoxide (CO), carbon dioxide (CO_2), oxygen (O_2), methane (CH_4), hydrogen sulfide (H_2S), nitrogen oxides (NO_x)), lighting, noise, respirable dust and thermal comfort measurements were made. The prevalence of SBS was determined as 64.7–74.1% in the hospitals. It was found that the risk of SBS was 4.31 times higher for those who complained about variable room temperature and 3.11 times higher for those who complained about noise, and decreased 1.01 times with the increase in lighting level. In order to minimize the risk of SBS, it is thought that all healthcare administrators should be informed about SBS.

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Sick building syndrome; indoor environmental quality; hospital staff

Introduction

Today, with the increase in urbanization, people spend almost 90% of their time indoors (Iyagba 2005). Buildings designed to keep pace with fast tempo of life and to lead a more comfortable, safer and easier life may adversely affect people's health over time (Zeybek 2014). This health problem, which is related to indoor air quality and stimulates mainly nervous system, skin and respiratory system, is defined as Sick Building Syndrome (SBS) (Hodgson and Adorisio 2005). The term 'Sick Building Syndrome' was used for the first time in 1983 by the world health organization (WHO), to describe situations in which building occupants experience acute health and comfort effects that appear to be linked to the time spent in a building, but no specific illness or cause can be identified (Zhang et al. 2012). And also in 1989 European Concerted Action (ECA) had defined SBS as 'the name given to a set of varied symptoms experienced predominantly by people working in air-conditioned buildings, although it has also been observed in naturally ventilated buildings.'(Molina et al. 1989).

SBS is a series of symptoms that occurs in an enclosed environment, disappears after abandonment and affects the majority of people living in the building. Symptoms start within a few hours and 15–30 minutes after the entry into the interior, and resolve within 30 minutes to several hours after leaving the building. Inadequate ventilation, chemical and microbial pollution are the most important reasons of SBS in buildings where heat insulation is prominent (Oanh and Hung 2005; Spellman 2008). The most common classification of health risk factors in built environments are; biological, chemical, physical, psychosocial, personal and other risk factors (Yassi et al. 2001). Classified health risk factors in built environments with their main parameters are (Dovjak and Kukec 2014, 2019; Kukec and Dovjak 2014);

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- Biological: Moulds, Bacteria, Microbes volatile organic compounds, House dust
- Chemical: Construction and household products, Formaldehyde, Phthalates, Man-made mineral fibres, Volatile organic compounds, Odours, Environmental tobacco smoke, Other indoor air pollutants
- Physical: Environmental parameters of thermal comfort, Parameters related to building ventilation, Noise, vibrations, Daylight, Electromagnetic fields, Ions, Ergonomics, Universal design
- Psychosocial: Occupational stress, Social status, Loneliness, helplessness, Work organization, communication, supervision
- Personal: Gender, Individual characteristics, health status
- Others: Location, geo-pathogenic zones, Building characteristics, Ownership, Presence of insect, rodents, use of insecticide, disinfection, rat-killing products

SBS can occur in workplaces such as office buildings, universities and hospitals (Vazifeshenas and Sajadi 2010). Improper indoor air quality in hospitals can lead to outbreaks of infectious diseases or building-related diseases, such as headache, fatigue, eye irritation, and other symptoms among patients and hospital staff (WHO 1990; Nakata et al. 2002; Leung and Chan 2006; Vazifeshenas and Sajadi 2010). According to WHO, approximately 30% of new and renovated buildings worldwide may be affected by SBS (World Health Organization 1990). Moreover, much higher prevalence of SBS was demonstrated in hospital environment than in other public buildings. A review study by Kalender Smajlović et al. found that the prevalence of SBS in hospitals rose from 41% to 87% (Smajlović et al. 2019b). On the other hand, SBS prevalence was found to be 20.9% in a study at a hospital in Turkey (Arikan et al. 2018).

Hospitals are one of the institutions where various chemicals are used and workers are easily affected by factors such as noise, lighting, ventilation, ergonomics and stress (Özyaral and Keskin 2007). Especially in the operating room, intensive care units, radiology, pathology, biochemistry and clinical microbiology laboratories, chemicals and materials and solutions used for cleaning and disinfection cause various health problems in individuals (Özyaral and Keskin 2009).

SBS, generally occurs with headache and drowsiness symptoms; eyes, nose, throat and dry skin of a group of mucous membrane symptoms of unknown cause includes symptoms (Burge 2004; Marmot et al. 2006; Li et al. 2015). These symptoms include; headache, dizziness, nausea, eye, nose or throat discomfort, dry cough, dry skin, skin itching, difficulty in concentration, fatigue, odour sensitivity, hoarseness, allergies, colds, asthma attacks and personality changes (Joshi 2008). While the most common symptoms in some studies are headache, fatigue and dry skin (Vafaeenasab et al. 2015), there are also studies in which weakness and exhaustion are considered as the most common symptoms (Gomzi et al. 2007).

SBS, decreases the productivity of individuals and increases absenteeism by causing illness, fatigue and exhaustion in individuals (Vafaeenasab et al. 2015). It has been shown that productivity improves between 7% and 15% with the enhancement of the living conditions of workers in the workplace and the absenteeism of work due to illness or unwillingness decreases significantly (Tarcan et al. 2000).

There are a limited number of studies investigating the relationship between SBS and indoor environmental quality in hospitals in our country. The aim of this study was to determine the prevalence of SBS on people working in the hospital environment and to find out the factors affecting it and its relationship with indoor environmental quality.

Materials and methods

This study, which was studied in May 2019–January 2020, General State Hospital (GSH), Oral and Dental Health Hospital (ODHH) and in a District State Hospital (DSH) of Sivas located in Turkey's Central Anatolia Region, is a cross-sectional research. GSH was established on 150 decares of land in the city centre, its total closed area is 104.000 m^2, and it is a five-year-old building. ODHH is also in the city centre, its total closed area is 6460 m^2, and it is a seven-year-old building. DSH is located in Gürün district, 136 km away from the city centre, its total closed area is 6012 m^2 and it is a three-year-old building. All three buildings have the same characteristics. The outside of the buildings has heat insulated high reflective glasses and a barrier curtain wall. Heating, cooling and ventilation in all closed areas is provided by an air conditioning consisting of air handling units, cooling groups and aspirators, and hygienic air conditioning in operating rooms. Artificial lighting is used in places that do not have windows opening to the outside. The internal floors are covered with ceramic. Water, 1/10 diluted bleach and detergent are used in the general cleaning of the buildings, and a mopping system is used for floor cleaning. In addition, all closed areas are regularly disinfected three times a week with a disinfectant containing hydrogen peroxide. Disinfection is carried out by fogging method with chlorine dioxide containing disinfectant only in ODHH.

Considering that the concentration of respirable particles is one of the most important factors in indoor environmental quality, about these concentrations it was decided to work in hospital indoor environments that were found to be higher than the World Health Organization (WHO) and United States Environmental Protection Agency (US-EPA) standards (Mohammadyan et al. 2017). Therefore, the study conducted in operating rooms, intensive care units (neonatal, coronary and general), laboratories (microbiology, biochemistry, and pathology), blood collection unit, plaster room, sterilization unit, emergency room, boiler room, generator room and laundry departments in the hospitals. In these departments, there are 310 staff in GSH, 33 staff in ODHH and 20 staff in DSH. As the prevalence of SBS in hospitals rose from 21% to 87% (Arikan et al. 2018; Smajlović et al. 2019b), the prevalence of SBS in this study was taken as %50. So the sample size was calculated as 172 staff in GSH, 31 staff in ODHH and 20 staff in DSH using the Rao soft program with 95% confidence interval and 5% error margin. However, the study was carried out with 249 staff in GSH, 31 staff in ODHH and 20 staff in DSH who agreed to participate in the study. All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the Ethics Committee of Cumhuriyet University approved the protocol (Project identification code: 2019–04/18).

The MM 040 NA questionnaire was distributed to the participants by researchers and filled face to face. Air quality (carbon monoxide (CO), carbon dioxide (CO_2), oxygen (O_2), methane (CH_4), hydrogen sulfide (H_2S), nitrogen oxides (NO_x)), lighting, noise, dust and thermal comfort measurements were performed in the hospitals' internal environments.

MM 040 NA Hospital questionnaire is a standard, valid questionnaire developed by Örebro University Hospital Department of Occupational and Environmental Medicine to evaluate SBS symptoms and indoor air quality (Andersson 1998). The questionnaire includes questions about perceived indoor air quality, emerging symptoms and potential relationships with the indoor environment, in addition to the psychosocial environment and some basic factors. When evaluating the symptoms of SBS, individuals with at least one of the previously diagnosed asthma, chronic pharyngitis and chronic rhinitis were excluded. The staff involved in the study attend the investigated environments. The participants responded to the symptoms (min. 0, max. 15 symptoms) as 'Yes, frequently (every week)' during the last 3 months were counted. The symptoms were classified into five groups as nasal (irritated, stuffy or runny nose), ocular (itching, burning or irritation of the eyes), throat (hoarse, dry throat, cough), skin (dry or flushed facial skin, scaling/itching scalp or ears, hands dry, itching, red skin) and general symptoms (fatigue, feeling heavy-headed, headache, nausea/dizziness, difficulties concentrating, stress, easily irritation, sleeplessness). If at least one of the questions in this SBS symptoms group answered as 'Yes, often (every week)' during the last 3 months, it was accepted that there was a risk of SBS. Symptoms were additionally grouped as 0–1, 2–3, 4–5, 6 and above to compare the percentage of incidence in different hospital departments.

Indoor environmental quality measurements were made by experts on the subject and by means of a firm, which have the following documents: 'Laboratory Competence Certificate' from the Ministry of Environment and Urbanization, 'Accreditation Certificate' from the Turkish Accreditation Agency (TURKAK) and 'Occupational Hygiene Laboratory Qualification Certificate' from the Ministry of

Table 1. Distribution of general characteristics of staff in hospitals according to hospital departments (n = 300).

Hospital	General characteristics			Group 1* (n = 159)	Group2* (n = 34)	Group 3* (n = 45)	Group 4* (n = 11)
General State Hospital (n = 249)	Gender-n (%)	Male	90 (36.1)	45 (28.3)	14 (41.2)	20 (44.4)	11 (100)
		Female	159 (63.9)	114 (71.7)	20 (58.8)	25 (55.6)	0 (0)
	Age (X± SD)		34.5 ± 9.3	34.7 ± 9.3	35.8 ± 9.4	31.4 ± 9.6	40.5 ± 3.8
	Occupation-n (%)	Doctor	12(4.8)	8 (5.0)	3 (8.8)	1 (2.2)	0 (0)
		Nurse	144(57.8)	106 (66.7)	3 (8.8)	35 (77.8)	0 (0)
		Midwife	4(1.6)	4 (2.5)	0 (0)	0 (0)	0 (0)
		Medical officer	65(26.1)	31 (19.5)	28 (82.4)	6 (13.3)	0 (0)
		Administrative staff	5(2.0)	5 (3.1)	0 (0)	0 (0)	0 (0)
		Technical staff	10(4.0)	2 (1.3)	0 (0)	2 (4.4)	6 (54.5)
		Cleaning staff	9(3.6)	3 (1.9)	0 (0)	1 (2.2)	5 (45.5)
	Working hours-n (%)	Full time	235(94.4)	148 (93.1)	34 (100)	42 (93.3)	11 (100)
		Part time	14(5.6)	11 (6.9)	0 (0)	3 (6.7)	0 (0)
	Night working-n (%)	Yes, always	77(30.9)	48 (30.2)	1 (2.9)	27 (60.0)	1 (9.1)
		Yes, sometimes	100(40.2)	84 (52.8)	7 (20.6)	6 (13.3)	3 (27.3)
		No, never	72(28.9)	27 (17.0)	26 (76.5)	12 (26.7)	7 (63.6)
	Smoking-n (%)	Yes	76(30.5)	45 (28.3)	8 (23.5)	16 (35.6)	7 (63.6)
		No	173(69.5)	114 (71.7)	26 (76.5)	29 (64.4)	4 (36.4)
				Group 5* (n = 10)	**Group6* (n = 10)**	**Group 7* (n = 11)**	
Oral and Dental Health Hospital (n = 31)	Gender-n (%)	Male	17 (54.8)	1 (10.0)	6 (60.0)	10 (90.9)	
		Female	14 (45.2)	9 (90.0)	4 (40.0)	1 (9.1)	
	Age (X± SD)		32.0 ± 10.6	22.1 ± 5.3	32.4 ± 9.1	40.6 ± 7.8	
	Occupation-n (%)	Doctor	1(3.2)	0 (0)	1 (10.0)	0 (0)	
		Nurse	2(6.5)	1 (10.0)	1 (10.0)	0 (0)	
		Medical officer	12(38.7)	9 (90.0)	3 (30.0)	0 (0)	
		Administrative staff	3(9.7)	0 (0)	3 (30.0)	0 (0)	
		Technical staff	2(6.5)	0 (0)	2 (20.0)	0 (0)	
		Cleaning staff	11(35.5)	0 (0)	0 (0)	11 (100)	
	Working hours-n (%)	Full time	31(100)	10 (100)	10 (100)	11 (100)	
	Night working-n (%)	Yes, sometimes	3(9.7)	0 (0)	3 (30.0)	0 (0)	
		No, never	28(90.3)	10 (100)	7 (70.0)	11 (100)	
	Smoking-n (%)	Yes	11(35.5)	1 (10.0)	3 (30.0)	7 (63.6)	
		No	20(64.5)	9 (90.0)	7 (70.0)	4 (36.4)	
				Group 8* (n = 5)	**Group 9* (n = 2)**	**Group 10* (n = 6)**	**Group 11* (n = 7)**
District State Hospital (n = 20)	Gender-n (%)	Male	6 (30.0)	0 (0)	0 (0)	3 (50)	3 (42.9)
		Female	14 (70.0)	5 (100)	2 (100)	3 (50)	4 (57.1)
	Age (X± SD)		33.9 ± 8.04	32.4 ± 7.2	28.5 ± 0.7	31.8 ± 8.2	38.4 ± 8.5
	Occupation-n (%)	Doctor	3(15.0)	2 (40.0)	1 (50.0)	0 (0)	0 (0)
		Nurse	10(50.0)	3 (60.0)	0 (0)	6 (100)	1 (14.3)
		Medical officer	1(5.0)	0 (0)	1 (50.0)	0 (0)	0 (0)
		Technical staff	1(5.0)	0 (0)	0 (0)	0 (0)	1 (14.3)
		Cleaning staff	5(25.0)	0 (0)	0 (0)	0 (0)	5 (71.4)
	Working hours-n (%)	Full time	16(80.0)	3 (60.0)	1 (50.0)	6 (100)	6 (85.7)
		Part time	4(20.0)	2 (40.0)	1 (50.0)	0 (0)	1 (14.3)
	Night working-n (%)	Yes, always	4(20.0)	0 (0)	0 (0)	2 (33.3)	2 (28.6)
		Yes, sometimes	12(60.0)	3 (60.0)	1 (50.0)	4 (66.7)	4 (57.1)
		No, never	4(20.0)	2 (40.0)	1 (50.0)	0 (0)	1 (14.3)
	Smoking-n (%)	Yes	4(20.0)	0 (0)	0 (0)	1 (16.7)	3 (42.9)
		No	16(80.0)	5 (100)	2 (100)	5 (83.3)	4 (57.1)

*Group 1: Intensive care units, Operating room; Group 2: Laboratories (pathology, microbiology, biochemistry); Group 3: Blood collection department, Emergency room, Plaster room; Group 4: Sterilization, Boiler room, Laundry, Generator room, Carpentry; Group 5: Prosthesis laboratory, Group 6: Polyclinics, Group 7: Laundry, Sterilization; Group 8: Intensive care units, Operating room; Group 9: Laboratories; Group 10: Emergency department; Group 11: Sterilization, Boiler room, Laundry

Family, Labor and Social Services. Air quality (CO (ppm), CO_2 (ppm), O_2 (vol%), CH_4 (%LEL), H_2S (ppm), NO_x (ppm)) measured with Industrial Scientific MX6 Multiple Gas Meter (Industrial Scientific Corporation., Pittsburgh, PA USA); thermal comfort measurements (air temperature (°C), relative humidity (%)) measured with Delta OHM HD32.3 (Caselle di Selvazzano (PD) Italy); noise level (dB(A)) measured with CESVA SC 310 (Maracaibo, Barcelona, Spain); respirable dust (mg/m^3) measured with LP-5 Libra Plus Buck (Orlando, USA); lighting level (lx) measured with Extech SDL400 (Test Equipment Depot, Boston, Massachusetts, USA).

In order to evaluate the air quality, the chemicals in the environment were taken at three points (4 measurements for CO_2) at the points determined by the company officials, and their average values were written. Measuring locations and measuring times were chosen to represent chemical gas exposed during a typical working day at which the population was at risk. Before each measurement, the instruments were calibrated. Thermal comfort measurements were carried out in process units and offices in the production area, during a time period corresponding to the maximum heat pressure, when the heat generation equipment was in operation. In the noise level measurement, the device was placed at the ear distance of the employee, telling the employee not to change the daily tempo, not to turn off the collar microphone or to react unnecessarily to the microphone. Exposure was calculated by taking three measurements for each task in each task. Respirable dust measurements were made at the breath distance by gravimetric method. Glass fibre filter paper with a holding rate of 1.6 mic was used for the measurement. Lighting level measurements were made by keeping the device sensor parallel to the working area field of view and the field of vision. Four points were chosen to represent task plane measurements such as bench, table, manufacturing machine, etc. and measurements were made at the centres of these points. Measurements were taken outside the counter at the point where the measurement staff stopped (1 meter from the ground). The number of measurements taken according to the hospital departments are given in Tables 3–5.

The legally recommended limit values (lower limit – upper limit) for indoor environment were accepted as 35 ppm (upper limit) for CO (Carbon Monoxide In Workplace Atmospheres, OSHA Method ID-210, March 1991), 1000 ppm for CO_2 (upper limit) (ASHRAE 2001), 19.5% – 23.5% for O_2 (Durukan 2013), 1% for CH_4 (upper limit) (Durukan 2013), 10 ppm for H_2S (upper limit) (OSHA), 5 ppm for NO_x (upper limit) (OSHA), 20°C −25.5°C for temperature [30], 30% −60% for relative humidity (Hermans et al. 2008), 35 dB (A) – 45 dB (A) for noise (Çevresel Gürültünün Değerlendirilmesi ve Yönetimi Yönetmeliği 2002), for respirable dust 5 mg/m^3 (upper limit) (Hermans et al. 2008) and 100 lx (lower limit) for lighting (EN (European Standad) 2002).

Hospital departments were divided into groups with the same characteristics in terms of exposure to environmental factors. In GSH, intensive care units and operating room as Group 1; laboratories (pathology, microbiology, biochemistry) as Group 2; blood collection room, emergency room, plaster room as Group 3; sterilization, boiler room, laundry, generator room, carpentry group were classified as Group 4. In ODHH, prosthesis laboratory as Group 5; polyclinics as Group 6; laundry, sterilization as Group 7 were classified. In DSH, intensive care units, operating room as Group 8; laboratories as Group 9; emergency department as Group 10; sterilization, boiler room, laundry as Group 11 were classified.

The data obtained from our study were evaluated with SPSS 22.0 program. Descriptive statistics such as mean, standard deviation and percentage distribution were calculated. The normality of the data was analysed by Kolmogorov-Simirnov test. Since the data did not meet the parametric conditions, Mann Whitney U test was used for two independent groups and Kruskal Wallis test was used for more than two groups. Chi-square test was used to evaluate the data obtained by counting. Logistic regression analysis was performed. To determine the relationship between the factors in which GSH staff feel uncomfortable with the hospital environment and the risk of SBS; draught, room temperature too high, varying room temperature, room temperature too low, stuffy 'bad' air, dry air, unpleasant odour, static electricity, often causing shocks, passive smoking, noise, light that is dim or causes glare and/or reflections, dust and dirt were included in the model. And

Table 2. Prevalence and distribution of sick building syndrome symptoms among hospital staff according to hospital departments.

Hospital			Group1* (n = 126)	Group2* (n = 28)	Group 3* (n = 36)	Group 4* (n = 9)	
General State Hospital (n = 199)**	Number of symptoms (min 0/max 15) (X± SD)	4.8 ± 4.6	6.1 ± 4.6	3.4 ± 4.2	1.5 ± 2.8	4.8 ± 1.6	χ2 = 37.339 p = **0.001**
	Significant difference (χ2; p) Group 3- Group 1: 65.185; **0,001** Group 2- Group 1: 36.456; **0,013**						
	0–1 symptom-n(%)	79(39.7)	35(27.8)	14(50.0)	26(72.2)	4(44.4)	x^2 = 32.975 p = **0.001**
	2–3 symptom -n(%)	14(7.0)	7(5.6)	3(10.7)	4(11.1)	0(0)	
	4–5 symptom -n(%)	28(14.1)	20(15.9)	4(14.3)	2(5.6)	2(22.2)	
	6 symptoms or more -n(%)	78(39.2)	64(50.8)	7(25.0)	4(11.1)	3(33.3)	
	Nasal symptoms- Yes, often-n(%)	64(32.2)	40(31.7)	6(21.4)	17(47.2)	1(11.1)	x^2 = 7.059 p = 0.070
	Ocular symptoms- Yes, often-n(%)	58(29.1)	40(31.7)	4(14.3)	12(33.3)	2(22.2)	x^2 = 3.921 p = 0.278
	Throat-related symptoms- Yes, often-n(%)	51(25.6)	31(24.6)	5(17.9)	14(38.9)	1(11.1)	x^2 = 5.273 p = 0.153
	Skin-related symptoms- Yes, often-n(%)	95(47.7)	58(46.0)	9(32.1)	26(72.2)	2(22.2)	x^2 = 13.875 p = **0.003**
	General symptoms- Yes, often-n(%)	138 (69.3)	85(67.5)	19(67.9)	32(88.9)	2(22.2)	x^2 = 16.110 p = **0.001**
	Risk of sick building syndrome -n(%) 143 (71.9)						
			Group5* (n = 8)	**Group6* (n = 8)**	**Group 7* (n = 11)**		
Oral and Dental Health Hospital (n = 27)**	Number of symptoms (min 0/max 15) (X± SD)	3.1 ± 2.7	5.1 ± 2.5	4.1 ± 2.1	1.0 ± 1.7		χ2 = 10.481 p = **0.005**
	Significant difference (χ2; p) Group 7- Group 5: 11.040; **0,007**						
	0–1 symptom-n(%)	12(44.4)	1(12.5)	1(12.5)	10(90.9)		x^2 = 20.886 p = **0.001**
	2–3 symptom -n(%)	2(7.4)	0(0)	2(25.0)	0(0)		
	4–5 symptom -n(%)	6(22.2)	3(37.5)	3(37.5)	0(0)		
	6 symptoms or more -n(%)	7(25.9)	4(50.0)	2(25.0)	1(9.1)		
	Nasal symptoms- Yes, often-n(%)	1(3.7)	0(0)	1(12.5)	0(0)		x^2 = 2.466 p = 0.593
	Ocular symptoms- Yes, often-n(%)	1(3.7)	0(0)	0(0)	1(9.1)		x^2 = 1.510 p = 1.000
	Throat-related symptoms-Yes, often-n(%)	7(25.9)	0(0)	0(0)	7(63.6)		x^2 = 13.745 p = **0.002**
	Skin-related symptoms- Yes, often-n(%)	8(29.6)	0(0)	2(25.0)	6(54.5)		x^2 = 6.726 p = **0.032**
	General symptoms- Yes, often-n(%)	19(70.4)	3(37.5)	5(62.5)	11(100)		x^2 = 9.015 p = **0.010**
	Risk of sick building syndrome -n(%) 20 (74.1)						

(*Continued*)

Table 2. (Continued).

Hospital			Group1* (n = 126)	Group2* (n = 28)	Group 3* (n = 36)	Group 4* (n = 9)	
			Group8* (n = 4)	**Group9* (n = 2)**	**Group 10* (n = 6)**	**Group11* (n = 5)**	
District State Hospital (n = 17)**	Number of symptoms (min 0/max 15) (X± SD)	2.2 ± 3.0	1.7 ± 1.7	3.0 ± 1.4	1.0 ± 1.5	3.8 ± 5.0	χ2 = 2.586 p = 0.460
	0–1 symptom-n(%)	12(70.6)	3(75.0)	1(50.0)	5(83.3)	3(60.0)	x^2 = 3.494
	4–5 symptom-n(%)	4(23.5)	1(25.0)	1(50.0)	1(16.7)	1(20.0)	p = 0.884
	6 symptoms or more -n(%)	1(5.9)	0(0)	0(0)	0(0)	1(20.0)	
	Nasal symptoms- Yes, often-n(%)	3(17.6)	1(25.0)	0(0)	1(16.7)	1(20.0)	x^2 = 0.600 p = 1.000
	Ocular symptoms- Yes, often-n(%)	2(11.8)	0(0)	0(0)	1(16.7)	1(20.0)	x^2 = 1.266 p = 1.000
	Throat-related symptoms- Yes, often-n(%)	1(5.9)	0(0)	0(0)	0(0)	1(20.0)	x^2 = 2.550 p = 0.647
	Skin-related symptoms- Yes, often-n(%)	7(41.2)	1(25.0)	0(0)	3(50.0)	3(60.0)	x^2 = 2.756 p = 0.557
	General symptoms- Yes, often-n(%)	8(47.1)	1(25.0)	2(100)	3(50.0)	2(40.0)	x^2 = 3.152 p = 0.469
	Risk of sick building syndrome -n(%) 11 (64.7)						

*Group 1: Intensive care units, Operating room; Group 2: Laboratories (pathology, microbiology, biochemistry); Group 3: Blood collection department, Emergency room, Plaster room; Group 4: Sterilization, Boiler room, Laundry, Generator room, Carpentry; Group 5: Prosthesis laboratory, Group 6: Polyclinics, Group 7: Laundry, Sterilization; Group 8: Intensive care units, Operating room; Group 9: Laboratories; Group 10: Emergency department; Group 11: Sterilization, Boiler room, Laundry. ** Persons previously diagnosed with asthma, chronic rhinitis and chronic pharyngitis were excluded.

χ2, Kruskal Wallis test

Table 3. Distribution of indoor environmental quality parameters according to departments in General State Hospital.

Measurement			Group1*	Group2*	Group 3*	Group 4*	
O_2 (% vol)	n	9	0	3	2	4	
	Mean	21.24		21.26	21.35	21.17	χ2 = 2.815
	Median	21.20		21.30	21.35	21.20	p = 0.245
	Min	21.10		21.20	21.30	21.10	
	Max	21.40		21.30	21.40	21.20	
Air temperature (°C)	n	14	4	3	3	4	
	Mean	27.81	26.40	26.34	31.22	27.77	χ2 = 4.951
	Median	25.63	25.31	27.30	25.33	26.08	p = 0.175
	Min	20.37	20.37	25.72	25.11	24.25	
	Max	29.57	27.19	29.57	25.48	27.19	
Level of relative humidity in (%)	n	14	4	3	3	4	
	Mean	27.81	26.40	26.34	31.22	27.77	χ2 = 1.570
	Median	26.81	26.32	26.05	28.27	27.69	p = 0.666
	Min	23.43	24.01	26.05	26.59	23.43	
	Max	38.82	28.95	26.93	38.82	32.28	
Noise level in (dB(A))	n	10	3	2	1	4	
	Mean	75.05	62.03	66.30	66.90	89.47	χ2 = 2.857
	Median	68.80	59.60	66.30	66.90	89.20	p = 0.414
	Min	58.10	58.10	63.80	66.90	70.60	
	Max	108.90	68.40	68.80	66.90	108.90	
Respirable dust (mg/m^3)	n	10	0	3	3	4	
	Mean	1.79		0.80	2.67	1.88	χ2 = 4.273
	Median	1.43		0.78	2.83	1.41	p = 0.118
	Min	0.43		0.43	1.68	1.06	
	Max	3.65		1.19	3.51	3.65	
Level of lighting in (lx)	n	14	3	3	3	5	
	Mean	480.03	702.50	814.33	389.50	200.30	χ2 = 8.269
	Median	301.75	582.50	836.75	269.25	205.00	p = 0.041**
	Min	122.00	339.50	330.50	195.25	122.00	
	Max	1275.75	1185.50	1275.75	704.00	273.00	
**Significant difference-Grup (χ2; p)	1–2	−0.667;0.845		3–2	4.667;0.172		
	4–3	2.867;0.348		4–1	6.867;0.025		
	3–1	4.000;0.242		4–2	7.533;0.014		

*Group 1: Intensive care units, Operating room; Group 2: Laboratories (pathology, microbiology, biochemistry); Group 3: Blood collection department, Emergency room, Plaster room; Group 4: Sterilization, Boiler room, Laundry, Generator room, Carpentry
χ2, Kruskal Wallis test

also to determine the relationship between SBS risk of hospital staff and indoor environmental quality parameters; levels of O_2, air temperature, relative humidity, noise, respirable dust and lighting were included in the models separately. The error level was taken as 0.05.

Results

Table 1 shows the distribution of general characteristics of hospital staff according to the departments of hospitals. Most of the participants were women (GSH- 63.9%, DSH- 70%) in GSH and DSH, mean age was similar for both hospitals (GSH, 34.5 ± 9.3; DSH, 33.9 ± 8.04), nurses were the majority in occupation (GSH- 57.8%, DSH- 50%), most of them have been worked full time (at least 30 hours per week) (GSH- 94.4%, DSH- 80%) and at night (always or sometimes) (GSH- 71.1%, DSH-80%), non-smokers (GSH- 69.5%, DSH- 80%) were the majority. In ODHH, most of the participants were male (54.8%), the mean age was 32.0 ± 10.6 years, as a profession health officers were the majority (38.7%), all of them have been worked full time (at least 30 hours per week), staff not working at night (90.3%) and non-smokers (64.5%) were the majority.

The prevalence and distribution of SBS symptoms in hospital staff by hospital departments are presented in Table 2. The mean number of symptoms among hospital staff working in Group 1 in GSH was found to be significantly higher than those in Group 2 and 3 ($p < 0.05$). In ODHH, the mean number of symptoms of those working in Group 5 was significantly higher than that of those working in Group 7 ($p < 0.05$). Those who defined of 0–1 SBS symptoms also in every three

Table 4. Distribution of indoor environmental quality parameters according to departments in Oral and Dental Health Hospital.

Measurement			Group5*	Group6*	Group 7*	
O_2 (% vol)	n	4	1	1	2	
	Mean	21.30	21.30	21.30	21.30	χ2 = 0.000
	Median	21.30	21.30	21.30	21.30	p = 1.000
	Min	21.20	21.30	21.30	21.20	
	Max	21.40	21.30	21.30	21.40	
Air temperature (°C)	n	2	1	1	0	
	Mean	25.07	24.58	25.56		U = 1.000
	Median	25.07	24.58	25.56		p = 1.000
	Min	24.58	24.58	25.56		
	Max	25.56	24.58	25.56		
Level of relative humidity in (%)	n	2	1	1	0	
	Mean	31.91	29.87	33.95		U = 1.000
	Median	31.91	29.87	33.95		p = 1.000
	Min	29.87	29.87	33.95		
	Max	33.95	29.87	33.95		
Noise level in (dB(A))	n	2	1	1	0	
	Mean	74.10	84.40	63.80		U = 0.000
	Median	74.10	84.40	63.80		p = 1.000
	Min	63.80	84.40	63.80		
	Max	84.40	84.40	63.80		
Respirable dust (mg/m^3)	n	2	1	1	0	
	Mean	2.40	3.71	1.09		U = 0.000
	Median	2.40	3.71	1.09		p = 1.000
	Min	1.09	3.71	1.09		
	Max	3.71	3.71	1.09		
Level of lighting in (lx)	n	4	1	1	2	
	Mean	612.43	713.50	630.25	553.00	χ2 = 1.800
	Median	651.37	713.50	630.25	553.00	p = 0.407
	Min	433.50	713.50	630.25	433.50	
	Max	713.50	713.50	630.25	672.50	

*Group 5: Prosthesis laboratory, Group 6: Polyclinics, Group 7: Laundry, Sterilization
χ2, Kruskal Wallis test

hospitals were majority in number. 39.2% of those working in GSH, 25.9% of those working in ODHH and 5.9% of those working in DSH identified six or more symptoms. Those working in Group 1 in GSH and in Group 5 in ODHH were more likely to have 6 or more symptoms ($p < 0.05$). Staff in Group 2 and 3 in GSH and in Group 7 in ODHH were more likely to have 0–1 symptom ($p < 0.05$). The most common symptoms were general symptoms (GSH- 69.3%, ODHH- 70.4%, and DSH- 47.1%). In GSH skin-related and general symptoms were significantly more pronounced in Group 3 hospital departments' staff ($p < 0.05$). In ODHH throat-related, skin-related and general symptoms were significantly more pronounced in Group 7 hospital departments' staff ($p < 0.05$). The prevalence of SBS was found as 71.9% in GSH, 74.1% in ODHH and 64.7% in DSH.

Distribution of indoor environmental quality parameters according to departments in hospitals is presented in Table 3–5. It has not shown in table since CO, H_2S and NO_x were measured 0 ppm, CO_2 300 ppm and CH_4 0% in all three hospitals. In GSH, O_2, respirable dust and lighting levels were within the legally acceptable limits, and a significant difference was found among hospital departments ($\chi2 = 8.269$, $p = 0.041$). Accordingly, Group 3 (blood collection room, emergency department, plaster room) average level of lighting was more than Group 4 (sterilization, boiler room, laundry, generator room, carpentry); as for the mean level of lighting in Group 1 (intensive care units, operating room) was higher than Group 3. In GSH, the air temperature in laboratories, neonatal intensive care unit, sterilization, laundry and generator rooms was above 25.5°C. Relative humidity level was below 30% in laboratories, sterilization room, generator room, boiler room, plaster room, intensive care units and operating room. The noise level was above 45 dB (A) in all three hospitals. In ODHH and DSH, measurements other than the noise level were within legally acceptable limits.

Table 5. Distribution of indoor environmental quality parameters according to departments in District State Hospital.

Measurement			Group8*	Group9*	Group10*	Group11*	
O_2 (% vol)	n	5	1	1	0	3	
	Mean	21.28	21.30	21.40		21.23	χ2 = 2.815
	Median	21.30	21.30	21.40		21.20	p = 0.245
	Min	21.20	21.30	21.40		21.20	
	Max	21.40	21.30	21.40		21.30	
Air temperature (°C)	n	7	2	1	1	3	
	Mean	21.31	20.90	24.18	21.73	20.49	χ2 = 4.036
	Median	21.09	20.90	24.18	21.73	20.08	p = 0.258
	Min	19.76	20.72	24.18	21.73	19.76	
	Max	24.18	21.09	24.18	21.73	21.64	
Level of relative humidity in (%)	n	7	3	1	0	3	
	Mean	38.58	38.86	34.35		39.70	χ2 = 1.000
	Median	37.15	37.15	34.35		42.76	p = 0.607
	Min	32.16	36.41	34.35		32.16	
	Max	44.20	43.03	34.35		44.20	
Noise level in (dB(A))	n	7	2	1	1	3	
	Mean	63.78	58.05	69.90	59.10	67.13	χ2 = 2.857
	Median	59.10	58.05	69.90	59.10	68.90	p = 0.414
	Min	57.20	57.20	69.90	59.10	58.30	
	Max	74.20	58.90	69.90	59.10	74.20	
Respirable dust (mg/m^3)	n	7	2	1	1	3	
	Mean	0.82	0.53	0.44	0.80	1.16	χ2 = 4.893
	Median	0.69	0.53	0.44	0.80	1.25	p = 0.180
	Min	0.44	0.47	0.44	0.80	0.69	
	Max	1.54	0.59	0.44	0.80	1.54	
Level of lighting in (lx)	n	7	2	1	2	2	
	Mean	671.32	882.12	583.75	462.50	713.12	χ2 = 0.536
	Median	501.25	882.12	583.75	462.50	713.12	p = 0.911
	Min	105.50	285.50	583.75	423.75	105.50	
	Max	1478.75	1478.75	583.75	501.25	1320.75	

*Group 8: Intensive care units, Operating room; Group 9: Laboratories; Group 10: Emergency department; Group 11: Sterilization, Boiler room, Laundry
χ2, Kruskal Wallis test

Table 6. The relationship between the factors in which General State Hospital staff feel uncomfortable with the hospital environment and the risk of sick building syndrome (n = 199)*.

	Dependent variable**		
Categorical variables***	p	OR	95% CI
Draught	0.134	2.11	0.795–5.580
Room temperature too high	0.766	1.20	0.358–4.029
Varying room temperature	**0.014**	4.31	1.340–13.834
Room temperature too low	0.544	1.59	0.351–7.294
Stuffy 'bad' air	0.430	1.63	0.484–5.496
Dry air	0.807	1.17	0.337–4.055
Unpleasant odour	0.971	0.98	0.293–3.263
Static electricity, often causing shocks	0.090	4.83	0.781–29.876
Passive smoking	0.472	0.51	0.085–3.133
Noise	**0.029**	3.11	1.120–8.656
Light that is dim or causes glare and/or reflections	0.231	2.10	0.624–7.088
Dust and dirt	0.136	0.45	0.157–1.287

CI, confidence interval; OR, odds ratio.
*Persons previously diagnosed with asthma, chronic rhinitis and chronic pharyngitis were excluded.
**Reference category = There is no risk of sick building syndrome
***Reference category = No

The relationship between the factors in which GSH staff feel uncomfortable with the hospital environment and the risk of SBS is shown in Table 6. It was found that the risk of SBS was 4.31 times higher for those who complained about variable room temperature (p = 0.014, 95% CI = 1.340–13.834) and 3.11 times higher for those who complained about noise (p = 0.029, 95%

Table 7. The relationship between sick building syndrome risk of hospital staff and indoor environmental quality parameters*.

General State Hospital	p	OR	95% CI
O_2 (% vol) (n = 96)	0.284	14.94	0.106–2102.19
Air temperature (°C) (n = 171)	0.102	1.44	0.930–2.236
Level of relative humidity in (%) (n = 171)	0.075	1.06	0.994–1.122
Noise level in (dB(A)) (n = 184)	0.547	0.99	0.974–1.014
Respirable dust (mg/m^3) (n = 99)	**0.027**	0.59	0.378–0.944
Level of lighting in (lx) (n = 199)	0.947	1.00	0.999–1.001
Oral and Dental Health Hospital			
O_2 (% vol) (n = 27)	0.379	0.00	0.000–21,177.04
Air temperature (°C) (n = 19)	0.999	0.013	0.000-
Level of relative humidity in (%) (n = 19)	0.999	5536.28	0.000-
Noise level in (dB(A)) (n = 27)	0.180	0.94	0.866–1.027
Respirable dust (mg/m^3) (n = 19)	0.999	0.00	0.000-
Level of lighting in (lx) (n = 27)	**0.025**	0.99	0.984–0.999
District State Hospital			
O_2 (% vol) (n = 11)	0.887	9.31	0.000–1.961E+14
Air temperature (°C) (n = 13)	0.448	0.56	0.123–2.521
Level of relative humidity in (%) (n = 12)	0.338	1.13	0.880–1.450
Noise level in (dB(A)) (n = 13)	0.712	1.04	0.862–1.243
Respirable dust (mg/m^3) (n = 13)	0.234	8.11	0.259–253.834
Level of lighting in (lx) (n = 13)	0.119	0.99	0.994–1.001

CI, confidence interval; OR, odds ratio.
Reference category = There is no risk of sick building syndrome
*Persons previously diagnosed with asthma, chronic rhinitis and chronic pharyngitis were excluded.

CI = 1.120–8.656). In ODHH and DSH, significant relationship was not found between the factors disturbed by the hospital environment and the risk of SBS.

The relationship between the risk of SBS in hospital staff and indoor environmental quality parameters is shown in Table 7. Staff in departments without environmental measurement were not included in the analysis. It was found that the risk of SBS decreased 1.69 times with the increase in respirable dust level measured in GSH (p = 0.027, OR = 0.59, 95% CI = 0.378–0.944) and decreased 1.01 times with the increase in lighting level measured in ODHH (p = 0.025, OR = 0.99, 95% CI = 0.984–0.999).

Discussion

This cross-sectional study, which made in order to determine the prevalence of SBS in staff working in the hospital environment and factors affecting it and its relationship with indoor environmental quality, was conducted with a total of 300 health-care workers in a province and in three state hospitals of that province located in Turkey's Central Anatolia Region.

In our study, those who defined of 0–1 SBS symptoms also in every three hospitals were majority in number. 39.2% of those working in GSH, 25.9% of those working in ODHH and 5.9% of those working in DSH identified six or more symptoms. In a study conducted in Slovenia with 258 hospital workers (Smajlović et al. 2019b), those who defined 0–1 symptoms were majority in number (57.8%) similar to our study and it has been shown 12% of workers identified six or more symptoms. In the same study (Smajlović et al. 2019b), in the highest number of symptoms was seen in workers of surgical units. Similarly, in our study, the most symptoms had been identified in intensive care units and operating room. It has been occurred no other studies evaluating SBS symptoms according to the hospital departments.

In the literature, different results about the prevalence of SBS appear in studies conducted with hospital staff. In a study conducted with 126 hospital workers in Taiwan, it was found that approximately 84% of the workers defined at least one SBS syndrome (Chang et al. 2015). In a study conducted with 265 nurses working in surgical and intensive care units in three hospitals in Iran, the prevalence of SBS was 86.4% (Vafaeenasab et al. 2015). The fact that the study was performed only in surgical and intensive care units may have led to this result. In the study conducted with 177 secretaries who work at a hospital in Turkey, SBS prevalence was found to be 20.9% (Arikan et al. 2018). As for our study, the prevalence of SBS was found as 71.9% in GSH, 74.1% in ODHH and 64.7% in DSH. The reason why the prevalence of SBS is so different may be due to the different departments of the hospital where the studies are conducted. As a matter of fact, it is known that the risk of SBS is high in surgical units (Azizoğlu et al. 2019).

In our study, the most frequently described symptoms of the hospital staff were general symptoms. The symptoms associated with the skin and general in GSH were significantly defined in those working in the blood collection room, emergency department, and plaster room departments. The symptoms associated with the throat, skin and general in ODHH were significantly defined in those working in the laundry and sterilization departments. In the study of Smajlovic et al. (Smajlović et al. 2019b), the most common symptoms were nose symptoms, general symptoms, and skin-related symptoms, similar to our study. In a study conducted in geriatric hospitals in Sweden, the average weekly values were 30% for fatigue, 23% for eye irritation and 23% for dry face skin (Nordstrom et al. 1995). In the study of Chang and et al. the most frequent symptoms were nasal symptoms (66%) and eye symptoms (53%) (Chang et al. 2015). In Iran, in the study of Vafaeenasab et al. (2015) found that the most frequent symptoms of SBS (headache – 83.3%, fatigue – 89.6%) and skin-related symptoms (dry hand – 64.9%) were similarly to our study.

In our study, the noise level in three hospitals, which the research was high in all departments according to the legal limits. In some departments of GSH, the indoor temperature was high (in laboratories, neonatal intensive care unit, sterilization room, laundry and generator room) and relative humidity level found low (in laboratories, sterilization room, generator room, boiler room, plaster room, intensive care units and operating room). In a study conducted at the Slovenian hospital, Smajlović et al. 2019b) for all measurement locations in general; they detected the lighting level too low (83.3%), noise level too high (73.6%) and indoor temperature as inappropriate (55.3%).

In our study, it was found that varying room temperature and noise were the factors associated with the risk of SBS in GSH. The respirable dust level associated with the risk of SBS in GSH and the level of lighting in associated with the risk of SBS in ODHH. Also in many studies evaluating the risk of SBS in the hospital indoor environment, the height of noise level and lowness of lighting level appeared as important risk factors. As a matter of fact, hospitals are known as noisy places exceeding the limit values recommended by the World Health Organization (Rashid and Zimring 2008). Common sources of noise in healthcare settings include telephones, alarms, trolleys, ice machines, call systems, nurse shift changes, staff looking at other patients, door closure, staff talks, and patient crying or coughing (Ulrich et al. 2003). In a study conducted at a hospital in Turkey Arıkan et al. found that the risk of SBS was 1.2 times higher with an increase in the measured noise level (Arikan et al. 2018). In the study conducted in Iran, similar to our study, the prevalence of SBS was found to be significantly correlated with noise and low light (Keyvani et al. 2017). Nordstrom et al. (1995) found that eye irritation was more common in buildings with a high ventilation flow and a high noise level from the ventilation system. Niven et al. (Niven et al. 2000) studied five buildings and reported that there was a consistent positive relation in each building and in buildings overall, between SBS symptoms and particulates (strongest for the larger particle sizes (>10 μm)) and for noise variables. For the noise, they found that low-frequency noise was positively associated with symptoms (Niven et al. 2000). In their study with nurses and doctors working in anaesthesia and intensive care units in three different hospitals in Italy, Morghen et al. found that the percentage of high stress decreased with an increase in exposure to lighting although they were not statistically significant (Morghen et al. 2009).

Increasing temperature values in the work environment can cause a feeling of sleep and fatigue in the person (Yabana Kiremit 2018). Very few studies have been reported on the effects of ambient temperature in health-care settings. Nordstrom et al. (1995) found that ambient temperature had no effect on SBS in their study. Chang et al. (2015) found in their study in a medical centre in Taiwan that the ambient temperature varied between 20°C and 26°C and the relative humidity ranged between 63% and 75%. As a result of their analysis, they did not find a relationship between SBS related symptoms and indoor temperature (p = 0.54). But they found a relationship between relative humidity (p = 0.04), CO_2 (p = 0.02), particulate matter (p = 0.03) and symptoms (Chang et al. 2015). Smedbold et al., in a study conducted with 115 nurses in geriatric hospitals in Norway (Smedbold et al. 2002); determined in area which examined that the temperature was high, humidity and CO_2 rates were low, and that there was evidence of microbial amplification in ventilation systems. They concluded that the internal environment affects the nasal mucosa of the nurses and thus may cause nasal mucosal swelling (Smedbold et al. 2002). On the other hand Smajlovic et al. (2019b) established no statistically significant differences between the number of SBS symptoms among the obtained mean values for air temperature, level of lighting and noise level. In a four-year longitudinal study among personnel (n = 129) in six primary schools Norback et al. (1990) found that the incidence of new SBS was related to concentration of respirable dust, current smoking, and the psychosocial climate. Although we had found in our study that the risk of SBS decreased with the increase in the level of respirable dust, we think that the result we had found may not be very significant, since the respirable dust level we had measured in GSH did not exceed the legal limits (max 3.65 mg/m^3).

The present study is the first in Turkey to evaluate in a comprehensive manner the relationship between the prevalence of SBS in three separate hospital staff with the measured indoor environmental parameters. The strengths of the present study are that environmental measurements were made in three different hospitals (GSH, DSH, ODDH), the measurement results and SBS symptoms in the staff were analysed and were presented comparatively according to the hospital departments and that was worked with staff from every occupational group working in the hospitals.

The limitations of our study are that the environmental parameters of the indoor area were measured for a limited time, the seasonal effect was not taken into consideration, and the measurements were not taken in all departments of the hospitals, failure to carry out work with all staff working in hospital departments where the measurements were made. We recommend that these limitations be eliminated as much as possible in the future works.

As a result, in our study, the prevalence of SBS was determined as 71.9% in GSH, 74.1% in ODDH and 64.7% in DSH. SBS symptoms most frequently described by hospital staff were general symptoms (GSH- 69.3%, ODHH- 70.4% and DSH- 47.1%). In all three hospitals where the research was conducted, the noise level was higher than the legal limits in all departments. In some departments of GSH, according to legal limits or acceptable values, indoor air temperature was high and relative humidity was low. It was found that the risk of SBS was 4.31 times higher for those who complained about variable room temperature and 3.11 times higher for those who complained about noise, decreased 1.69 times with the increase in respirable dust level measured in GSH and decreased 1.01 times with the increase in lighting level measured in ODHH. In order to minimize the risk of SBS, it is thought that all healthcare administrators, especially hospital managers, should be informed about SBS and the factors that cause it and that they should make necessary arrangements to eliminate the risk factors we also identified in our study. Considering that the prevalence of SBS is higher in hospital settings, necessary arrangements can be made and healthy working environments can be created starting from the construction of the hospital. Therefore, not only health managers and healthcare professionals, but also maybe construction sector employees can also be made aware of the SBS. When these arrangements are made, the health complaints of the staff from SBS will decrease, worker satisfaction, productivity, performance and continuity to work will increase.

Conflicts of interest

The authors declare that they have no conflict of interest.

Ethics approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of University Cumhuriyet (No. 2019-04/18).

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