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ORIGINAL ARTICLE

Indoor Air Quality of a Medical Faculty Hospital and Its Effect on Those in the Environment

Bir Tıp Fakültesi Hastanesi İç Ortam Hava Kalitesi ve Ortamda Bulunanlara Etkisi

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ABSTRACT

Aim: The purpose of the current study is to measure indoor air quality parameters in a medical faculty hospital and to determine the medical complaints of hospital staff and patients/patient relatives regarding indoor air quality.
Methods: This cross-sectional, descriptive research was conducted with 442 participants between February 28 and March 22, 2021. For the indoor air quality in the hospital; temperature, relative humidity, air flow rate, light level, nitrogen oxide (NO), hydrogen sulfide (H2S), sulfur dioxide (SO2), carbon monoxide (CO), carbon dioxide (CO2) gas levels were evaluated according to the standards.
Results: It was determined that 80.3% of the air temperature and 22.7% of the relative humidity measurements in the study were in the standard limits and almost all of the air flow velocity and 81.0% of the illumination level measurements were not in standard limits. It was determined that particulate matter level was at normal levels according to International Organization for Standardization (ISO) 5 class in the all-environmental area. NO, H2S and SO2 were detected in the hospital with indoor gas measurements. CO gas was detected in a small part of the hospital. The majority of CO2 measurements were in line with standards. The most common symptoms of the participants associated with indoor air of the hospital were fatigue and dyspnea.
Conclusion: It was determined that some of the indoor air quality parameters did not comply with the standards and the participants had health complaints related to this. Indoor air quality parameters should be measured at regular intervals and necessary arrangements should be made to comply with the standards.

Keywords: Indoor air quality, Hospital, Health, Medical symptom

ÖZ

Amaç: Bu çalışmada bir tıp fakültesi hastanesinde iç ortam hava kalitesi parametrelerini ölçmek, hastane personelinin ve hasta/hasta yakınlarının iç ortam hava kalitesine ilişkin tıbbi semptomlarını belirlemek amaçlanmıştır.
Yöntem: Kesitsel tipteki bu araştırma 28 Şubat – 22 Mart 2021 tarihleri arasında, 442 katılımcıyla gerçekleştirilmiştir. Hastane iç ortam hava kalitesi için sıcaklık, bağıl nem, hava akım hızı, aydınlık düzeyi, nitrojen oksit (NO), hidrojen sülfür (H2S), sülfür dioksit (SO2), karbon monoksit (CO), karbon dioksit (CO2) gaz ölçümleri yapılarak standartlara göre değerlendirilmiştir.
Bulgular: Çalışmada ölçülen hava sıcaklığı ölçümlerinin %80,3'ünün, bağıl nem ölçümlerinin % 22,7'si standartlara uygun olduğu belirlendi. Ölçümlerin neredeyse tümünde hava akımı hızının standartlara uygun olmadığı belirlendi. Aydınlatma düzeyi ölçümlerinin %81,0'ının standartlara uygun olmadığı belirlendi. İç ortam partiküler madde düzeyi ölçümü ile tüm ortamların ISO 5 sınıfına ait olduğu tespit edildi. İç ortam gaz ölçümleri sonucu hastanede NO, H2S, SO2 gazlarına rastlanmadı. CO gazı hastanenin küçük bir kısmında tespit edildi. CO2 ölçümlerinin neredeyse tamamı standartlara uygundu. Katılımcıların hastanenin iç ortam havasıyla ilgili en sık görülen semptomları yorgunluk ve nefes darlığıydı.
Sonuç: İç ortam hava kalitesi parametrelerinden bir kısmının standartlara uymadığı ve buna bağlı katılımcıların sağlık yakınmaları belirlenmiştir. İç ortam hava kalitesi parametreleri düzenli aralıklarla ölçülmeli ve standartlara uygun olması için gerekli düzenlemeler yapılmalıdır.

Anahtar Kelimeler: İç hava kalitesi, hastane, insan sağlığı, semptom

Introduction

Indoor air pollution is defined as the presence of chemical, biological and physical factors that may harm human health in the indoor air of buildings (1). Indoor air quality contains lighting, ergonomics, acoustics and temperature factors in addition to pollutants such as carbon monoxide (CO), carbon dioxide (CO2) (2). Indoor temperature is the major parameter of thermal comfort. According to the American Society of Heating, Cooling and Air Conditioning Engineers (ASHRAE) standards, the temperature is expected to be 20-25.5 °C for ideal conditions. The relative humidity indoors should be in the range of 30-60%. In the absence of humidity in the air, breathing becomes difficult, infectious diseases, stress and fatigue may occur (3-5). Insufficient lighting causes accidents and decrease in work efficiency. The minimum illumination level in the working environment is accepted as 500 lux (6). The main sources of CO in indoor air are fireplaces, stoves, exhaust fumes from vehicles and cigarette smoke (7). The parameter that

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directly shows how intensively an environment is used by people is the CO2 concentration. Ambient air with a CO2 content of less than 1000 ppm is defined as 'acceptable indoor air quality' (8). Exposure to Hydrogen Sulfide (H2S) may cause eye and upper respiratory tract irritation (9). Due to exposure to sulfur dioxide (SO2), stenosis in the airways, wheezing and dyspnea occur (10). Nitrogen Oxide (NO) may cause eye irritation, exacerbation of asthma, and chronic respiratory diseases (11). Complex mixtures of inorganic and organic substances in the atmosphere are defined as particulate matter (PM) (12). The standard considered in terms of particulate matter is "ISO 14644-1:1999(E) Clean rooms and related controlled environments-Part 1: Classification of air cleanliness" (13).

The primary aim of the current descriptive study is to evaluate the physical factors (temperature, relative humidity, airflow rate, etc.) and indoor air quality in the hospital. The second is the comparison of these data with standard parameters. The third purpose is to reveal the environmental-related medical symptoms of the hospital staff and the patient/patient relatives in the hospital.

Methods

This cross-sectional descriptive study was conducted between February 28 and March 22, 2021. The sample size for the number of participants to be surveyed was calculated as a total of 435 using the "G-power" program, with 95% confidence interval, 85% power, 5% margin of error, 50% unknown prevalence rate and ½ the ratio of the groups.

Approval from Necmettin Erbakan University Non-Pharmaceutical and Medical Device Research Ethics Committee (Date: 19/02/2021, Number: 2021/3120), written permission from Medical Faculty Hospital Chief Physician, and informed consent form from the participants were obtained for the study. The research was funded by the Necmettin Erbakan University Scientific Research Projects Coordinatorship (Project No: 201518007).

The campus of university has 2 different hospitals. The new campus consists of a monoblock building with a capacity of 900 beds. The old campus consists of a total of 7 separate blocks of buildings and the deanery building. The hospital on the new campus uses central air-conditioning and ventilation systems, and there are large opening windows throughout the building. While one block of the buildings in the old campus (the oncology building) has central ventilation and air conditioning, the other buildings do not have central ventilation systems. All buildings in the old campus had operable windows. In this study, all measurements and evaluations were carried out in two different hospitals (old hospital campus; new hospital campus). Extech RH300 brand was utilized for temperature and humidity measurement; TSI 9515 brand portable anemometer for air flow velocity measurement, Extech EA31 brand for illumination level measurement, Cem DT-9880 brand for particulate matter measurement with dimensions of 0,3 µm, 0,5 µm, 1,0 µm, 2,5 µm, 5,0 µm, 10,0 µm, and Honeywell Multirae Lite brand for gas measurements. All measurements were carried out momentarily, at least 1 meter above the ground at the midpoint of the field, and at two different times; in the morning and in the afternoon.

The survey for hospital staff and patients/patient relatives, which was prepared by reviewing the current literature, consists of 27 items. It asks about socio-demographic characteristics, health status characteristics and symptoms related to indoor air quality (14-16). Questions to assess opinions and symptoms related to indoor air quality are listed in Table 2 and Table 3.

SPSS (Statistical Package for Social Sciences) 27.0 program was used for data analysis. Frequency data were given using numbers (n) and percent (%), numerical data using mean±standard deviation (sd), median (1st-3rd quartile). Chi-square (χ^2) test was used to compare categorical data. Compliance of numerical data with normal distribution was examined by Kolmogorov-Smirnov and Shapiro Wilk tests. Student t and One-Way ANOVA tests were employed to compare normally distributed numerical data. Tukey test was utilized for post hoc analysis of ANOVA test. Mann Whitney U and Kruskall-Wallis post hoc Dunn-Bonferroni tests were used for non-normally distributed numerical variables. In new and old hospital campuses, data according to departments were evaluated using two-way ANOVA test. Statistical significance level was accepted as p<0.05.

Results

In this research, 132 measurements were conducted in 40 different sections. 63.6% of the measured areas were in the new hospital campus and 36.4% were in the old hospital campus. The measurement areas were comprised of polyclinics 27.3%, inpatient clinics 24.2%, laboratories 12.1%, technical-support units 12.1%, administrative units 10.6%, social areas 9.1% and 4.6% operating rooms.

The mean temperature measurement value in all sections included in the research was determined as 22.81±2.03 °C. Comparison of temperature measurements conducted in hospital indoor environments according to departments was statistically significantly different (p=0.001). Temperature values measured in inpatient clinics were statistically higher than the values measured in outpatient clinics, social areas, technical-support units and administrative units (p values, respectively; p=0.001, p=0.001, p=0.001, p=0.007). The temperature values measured in social areas were statistically significantly lower than the values measured in outpatient clinics, inpatient clinics, laboratories and operating rooms (p values, respectively; p=0.027, p=0.001, p=0.024, p=0.029). Temperature values measured in hospital units were statistically significantly different in comparison to hospital campus (p=0.001, Figure 1A).

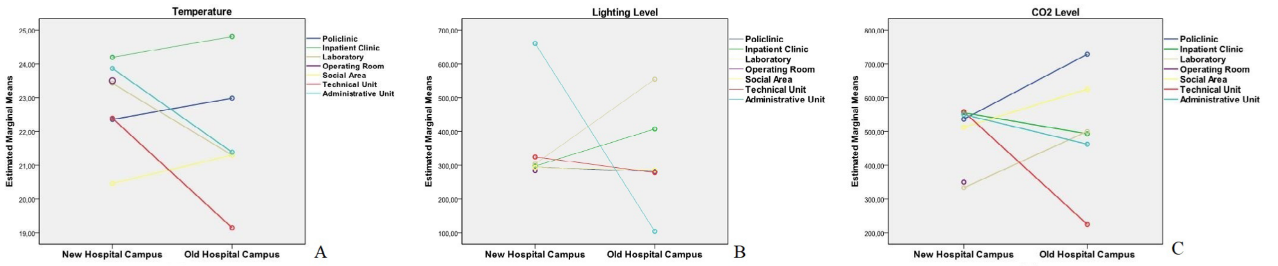

Figure 1. Temperature values (A), lighting (B) and carbon dioxide (CO_2) (C) levels in the units of university hospital (old campus and new campus)

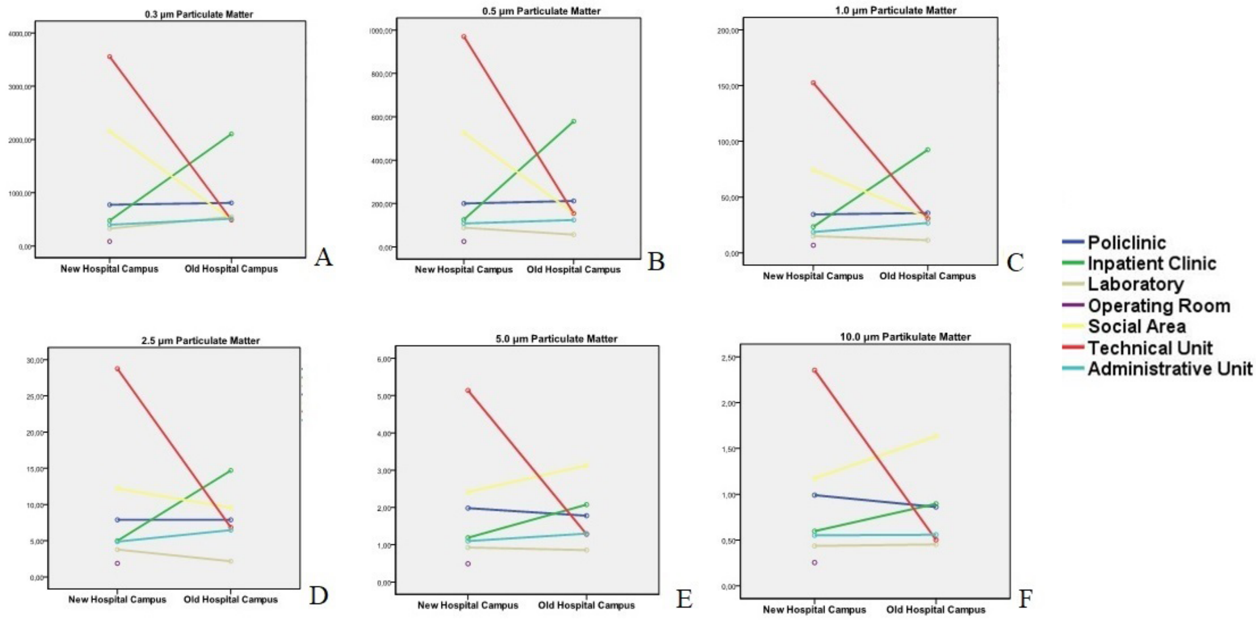

Figure 2. Levels of particulate matter (A: 0.3µm, B: 0.5 µm, C: 1.0 µm, D: 2.5 µm, E: 5.0 µm, F: 10.0 µm) in the units of university hospital according to diameters (old campus and new campus)

80.3% of all temperature measurements in the research were found acceptable in terms of the standards. The temperature measurements were evaluated according to the standards, and 15 measurements were lower than 20.0 °C and 11 measurements were higher than 25.5 °C. The compliance of the temperature measurements of the hospital units with the standards was statistically significantly different (p=0.004). This difference was due to the fact that the temperature measurements recorded in the polyclinic complied with the standards at a higher rate than in the other units.

The median of the relative humidity measurement value in the research was determined as 20.85% (16.62-29.00). Humidity measurements were compared according to the sections and there was statistically significant difference (p=0.003). The reason for this difference is that the humidity measurements conducted in the operating room were lower than the outpatient clinics, inpatient clinics, social areas, technical units and administrative units (p values are respectively; p=0.005, p=0.010, p=0.005, p=0.005, p=0.001). Laboratory measurements were lower in the outpatient and inpatient clinics (p values; p=0.035, p=0.020, respectively). Indoor relative humidity measurements in the new campus of the hospital were statistically significantly lower than the measurements in the old hospital campus (p=0.001). Statistically significant difference was not detected between the humidity values in the hospital units examined according to the hospital campus.

When the relative humidity measurements were evaluated according to the standards, a total of 102 measurements (77.2%) with a humidity level of less than 30% were detected while humidity measurements above 60% were not detected. It was determined that the relative humidity measurement in accordance with the standards was not recorded in the new hospital campus. The measurements in the new hospital campus were found lower than the standards at a higher rate when compared to the old hospital campus (p=0.001). Statistical difference was not found when the humidity measurement rates, which are in accordance with the standards and which are not in accordance with the standards, were compared according to the hospital units.

The median of the airflow measurement value in the hospital departments was determined as 10.0 (0.0-10.0) mm/sec. When airflow velocity measurements were compared according to the sections, statistically significant difference was not found. It was determined that the air flow velocity measurements in the old campus were lower than the air flow velocity measurements in the new campus (p=0.028). There was not statistical difference in the air flow velocity values in the hospital units according to the hospital campus.

When the airflow velocity values were compared according to the standards, the airflow velocity, which was in the range of 100-500 mm/sec, was determined in two measurements; one of the outpatient clinic measurements and one of the inpatient clinical measurements. 98.4% of all measurements conducted were not compatible with the standards. Both measurements within the standards were recorded in the old hospital campus.

The median of the indoor lighting level value was determined as 262.50 (152.00-431.50) lux. There was not statistically significant difference between the measurements of the illumination level according to the hospital departments. A statistically significant difference was determined in the lighting level values measured in the hospital units in comparison to the hospital campus (p=0.001). The illumination levels measured in the outpatient clinic, social area, technical-support unit and administrative units were higher in the new hospital campus, and the values measured in the inpatient clinics and laboratories were higher in the old hospital campus (Figure 1B).

When the illumination level values were compared according to the standards, 25 measurements were determined that they complied with the standards (>500 lux). 81.0% of the measurements were not compatible with the standards. Statistical difference was not found in the comparison of the appropriate and inappropriate lighting level measurements according to the hospital campus and hospital departments.

Particulate matter level measurements performed in the hospital are presented in Table 1. Measurements of all particulate matter dimensions were detected at similar levels in the old and new hospital campus. A statistically significant difference was found in measurements of all particulate matter dimensions according to hospital departments (p=0.001). When the particulate matter measurements in the indoor environment included in the research were evaluated according to the standards, it was observed that all measurements belonged to the ISO-5 class.

A statistically significant difference was detected in all particulate matter levels measured in hospital units compared to hospital campus (p=0.001). All particulate matter levels measured in technical-support units and outpatient clinics were detected higher in the new hospital campus, and all particulate matter levels measured in inpatient clinics were higher in the old campus. The 5.0 µm particulate matter levels measured in the social areas were higher in the old hospital campus, and the other particulate matter levels were higher in the new hospital campus. The level of 0.3 µm particulate matter measured in the laboratories was higher in the old hospital campus, and the other particulate matter levels were higher in the new hospital campus. Particulate matter levels measured in administrative units were similar in general in two campuses (Figure 2).

NO, SO2, and H2S gases were detected in any of the hospital departments included in the research.CO gas was detected in 11 of all measurements. The median of the CO gas value of the measurements in which CO gas was detected was recorded as 6.00 (4.00-7.00) ppm. All 11 measurements that detected CO gas were conducted at the new campus. Of these, 4 were recorded in social areas, 3 in technical-support units, 2 in outpatient clinics, and 2 in laboratories. Comparison of CO gas levels by hospital units was statistically different (p=0.009). This difference was due to the fact that the CO gas levels measured in the social areas were higher than in the other sections. CO gas measurements in the new hospital campus were statistically significantly higher than the measurements in the old hospital campus (p=0.009). When the CO measurements were examined according to the standards, a CO gas value over 9 ppm was detected in the canteen and the medical device unit in the new campus.

The median of the CO2 gas value in all measurements was 500.00 (300.00-600.00) ppm. Comparison of CO2 gas measurement values according to hospital units was statistically significantly different (p=0.001). The reason for this difference was that the CO2 levels measured in the laboratories were lower than the CO2 levels measured in the outpatient clinic, inpatient clinic and social areas (p value; p=0.005, p=0.005, p=0.030, respectively). A statistically significant difference was found in CO2 gas levels measured in hospital units according to hospital campus (p=0.002, Figure 1C). In 6 of the measurements, the CO2 gas level was determined as 1000 ppm and above, and it was noted that it did not comply with the standards.

There were 442 participants in the study, 292 of whom were hospital staff and 150 patients and their relatives. 53.2% of the participants were women and 66.3% were married. 81.7% of the participants were in the new hospital campus and 18.3% were in the old hospital campus. It was determined that 22.2% of the participants had at least one chronic disease, 23.1% were smokers, and 56.7% have had a respiratory tract infection at least once in the last 1 year.

It was determined that 63.8% of all participants had stress-tension, 45.7% had sleepiness, and 44.8% had headache complaints. 69.8% of those with dysesthesia, 64.6% of those with headache, and 52.8% of those with stress-tension were both in the hospital and outside the hospital. The presence of stress-tension was higher in hospital workers than in patients/patient relatives

Table 1. Evaluation of particulate matter level measurements

	Particulate matter, median (1-3. quartile)
0.3 µm (p/m[3])	526.28 (326.41-1208.25)
0.5 µm (p/m[3])	139.67 (85.48-300.32)
1.0 µm (p/m[3])	27.90 (17.96-48.06)
2.5 µm (p/m[3])	6.22 (3.97-9.36)
5.0 µm (p/m[3])	1.37 (0.82-2.42)
10.0 µm (p/m[3])	0.65 (0.39-1.10)

Table 2. Evaluation of the opinions of hospital staff and patients/patients' relatives regarding indoor conditions

	Hospital Staff (n=292)	**Patient/Patient relatives (n=150)**
	n (%)	n (%)
Does the atmosphere of the environment bother you when you first enter the hospital?	249 (85,3)	43 (71,3)
Do you go outside to get some air while you work?	292 (100,0)	122 (81,3)
Too little air intake	254 (87,0)	64 (42,2)
Too ventilated	164 (56,2)	30 (20,0)
Too dry	234 (80,1)	44 (29,3)
Too humid	115 (39,4)	7 (4,7)
So hot	226 (77,4)	64 (42,7)
Very cold	209 (71,6)	11 (7,3)
Very bright	192 (66,0)	65 (43,3)
Too dim	1179 (61,3)	20 (13,3)
Dusty	190 (65,1)	21 (14,0)
Airless/closed	235 (80,5)	39 (26,0)
Unpleasant odor is present	232 (79,5)	30 (20,0)
Busy	266 (91,1)	76 (50,7)

(p=0.025). The complaints of dyspnea, headache, stress-tension, itching-burning in the eyes were less common in hospital staff than patients/patient relatives outside the hospital (p=0.001).

The responses of hospital staff and patients/patients' relatives to the statements evaluating the internal environment are summarized in Table 2. 81.3% of the patients/patient relatives included in the research stated that they wanted to open windows in the hospital, and 50.7% stated that the hospital was crowded. Participants working in the old hospital campus stated that they perceived their environment as 'occasional cold' at a lower rate compared to the employees in the new campus (p=0.033). Other

Table 3. Evaluation of the symptoms in the hospital staff and patients/patients' relatives about the indoor environment conditions

	Hospital Staff (n=292)	**Patient/Patient relatives (n=150)**
	n (%)	n (%)
Sweating	224 (76,7)	71 (47,3)
Chill	205 (70,2)	19 (12,7)
Sleeping state	233 (79,8)	79 (52,7)
İnability to concentrate	227 (77,7)	43 (28,7)
Cough	147 (50,3)	24 (16,0)
Burning, sore throat	169 (57,9)	21 (14,0)
Sneeze	208 (71,2)	26 (17,3)
Dry mouth and nose	215 (73,6)	55 (36,7)
Runny nose	173 (59,2)	17 (11,3)
Nasal congestion	183 (62,7)	28 (18,7)
Shortness of breath	124 (42,5)	22 (14,7)
Headache	227 (77,7)	57 (38,0)
Dizziness, drowsiness	133 (45,5)	29 (19,3)
Burning eyes, itching	160 (54,8)	37 (24,7)
Nausea	126 (43,2)	16 (10,7)
Dry skin itching	170 (58,2)	38 (25,3)
Tiredness	262 (89,7)	87 (58,0)
Overwhelmed by the ambient air	248 (84,9)	77 (51,3)

internal environment perception assessments were similar in hospital staff in both campuses.

The rate of the patient/patient relatives in the old campus perceiving the ambient air uncomfortable, finding the environment too dry, too hot and crowded was higher than the patients/patient relatives in the new campus (p values were respectively; p=0.015, p=0.020, p). =0.032, p=0.018). The frequency of complaints of hospital staff and patients/patients' relatives participating in the research according to their internal environment is presented in Table 3. Statistically significant difference was not found when all internal complaints of the hospital staff were compared according to the old and new campuses of the hospital.

Discussion

According to a research conducted with 360 measurements in 12 different departments of a hospital in Slovenia, the median air temperature was 22.1 °C, the lowest temperature was 19.1 °C, and the highest air temperature was 25.7 °C. It was determined that 55.3% of all measurements were not at the recommended temperature value and the temperature value was statistically different between the sections (17). In this research, the indoor air temperature was found compatible with the literature. The high temperature measurements in inpatient clinics may be associated with the high circulation of both personnel and patient/patient relatives in inpatient clinics and the infrequent opening of windows. The low temperature values measured in social areas may be associated with the presence of these environments in the hospital entrance and basement floors, and the excessive ventilation of the environment due to the concern of COVID-19 infection transmission.

In a research conducted in 14 geriatric hospitals in Norway, the median indoor relative humidity level was found as 24% (17-26) (18). In this research, the relative humidity level was lower than in other studies. It was determined that humidity measurements made in the operating room and laboratories were lower than in other units. Since laboratories and operating rooms are critical points in the transmission of infectious agents, these areas do not have windows opening to the outside environment or the windows are not opened much and ventilation systems are operated more intensively than other units. It was considered that the absence of natural ventilation may cause the environment to be drier and the humidity measurements to be lower than other units.

In a research conducted in a hospital in Scotland, the average of indoor airflow velocity measurements was 0.056±0.008 m/s, and the airflow was insufficient in all patient rooms (19). In this research, it was determined that the level of airflow velocity measurement complied with the literature. It was considered that the low airflow velocity in all areas where the research was conducted and in the closed areas examined in the literature was caused by the ignoring of the air flow velocity by the indoor users in order to provide thermal comfort.

In a research conducted in different parts of a hospital in Iran, indoor lighting levels were measured at levels ranging from 93 lux to 9946 lux. It has been shown that there is a difference in lighting levels between hospital departments. It was determined that 52.2% of more than 90 measurements were below the standards (20). The illumination level measured in this research was lower in compliance with the standards compared to the literature. The large areas of hospital environments, basements, and the presence of windowless areas can cause daylight not to reach all areas adequately. It was thought that not preferring to turn on the light during daylight might cause the lighting level in hospital interiors to be insufficient.

According to the research conducted in a public hospital with 82 measurements, it was determined that the areas, of which particulate matter level was examined, belong to ISO 7 or ISO 8 class (21). Although all indoor environments in this research were not indoor environments designated as clean rooms, it was determined that the indoor environments in this research belonged to ISO class 5, and they were cleaner than the areas where other studies were carried out. It was considered that the effective and sufficient ventilation systems used in the areas where this research was conducted may have caused the current result.

In a research conducted in a university hospital in Tokyo, the average indoor NO gas level was 34.4±35.0 ppb, and the SO_2 gas level was 33.8±2.9 ppb on average, in accordance with the standards (22). In a research conducted by Akova et al. in 3 different hospitals, NO, H_2S, SO_2 gases were not detected in indoor environments (23). As a result of the measurements in this research, it was determined that there was not NO, H_2S and SO_2 gas in the indoor environment of the hospital.

In a research examining indoor air quality in 7 different departments of 37 different hospitals in Taiwan, the average CO was found as 2.7±1.2 ppm. In this research, it was determined that CO levels were not different according to hospital units (24). In this research, the places with high CO gas levels was determined were the canteen and medical device unit. Cooking in the canteen, burning an oven, and the lack of central ventilation and outside windows in the medical device unit may have caused this level to be high.

In a research examining the indoor air quality of 17 different polyclinics in Sanlıurfa, the CO_2 level of the polyclinics was measured above 1000 ppm in 13 polyclinics and it was found above the standards (25). In this research, it was determined that most of the CO_2 gas measurements complied with the standards. It was considered that the good ventilation systems of the hospital where the research was conducted and the low level of air pollution at the location of the hospital caused the low gas measurements.

In a research of 3811 staffs in Finnish hospitals that examined symptoms attributed to indoor air, 25% of participants had nasal irritation, 23% had eye irritation, and 21% had fatigue(26).In a multicenter research conducted with 28,862 participants in office, school and health care settings in Finland, 55.7% of the health professionals, who evaluated the indoor environments they were in, stated that the environment was stuffy and 49.9% found it dry (27).In this research the rates of health complaints related to the indoor environment were different, as in some of the previous studies on indoor air quality. Many factors such as the location of the building, its infrastructure, ventilation, air conditioning, the materials used in its construction, the chemicals and pollutants in it and the number of people affect the indoor air quality and therefore, the complaints of the individuals in the indoor environment. The fact that these research in the literature were carried out in different buildings in different countries can be shown as the reason for this difference.

Conclusion

It was determined that most of the indoor air temperature measurements were in accordance with the standards. It was determined that most of the measured humidity, air flow velocity and lighting levels were not in accordance with the standards. It was determined that all indoor environments belong to ISO 5 class in clean room classification. After indoor gas measurements (NO, H2S, SO2 gases) were made in the hospital, CO gas was detected in 2 parts of the hospital. It was determined that indoor CO2 level measurements were low and almost all of them were in compliance with the standards. The most common complaints of the hospital staff related to the internal environment of the hospital were determined as fatigue, suffocation from the ambient air, dysesthesia, inability to concentrate, headache, sweating, and dryness in mouth and in nose. The most common complaints related to the indoor environment of the patient/patient relatives were similar to those of the hospital staff; fatigue, dysesthesia, suffocation from ambient air, sweating and headache.

Abbreviations

NO: Nitrogen Oxide

H2S: Hydrogen Sulfide

SO2: Sulfur Dioxide

CO: Carbon Monoxide

CO2: Carbon Dioxide

ISO: International Organization for Standardization

ASHRAE: American Society of Heating, Cooling and Air Conditioning Engineers

PM: Particulate Matter

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Authors' contributions

GE, LSD: conception and design of the study and drafting the article. GE: collection of data and field work. All authors (GE, LSD) participated in the analysis and interpretation of data in addition to writing the manuscript. All authors have read and approved the final manuscript.

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Availability of data and materials

The data set produced during the current study is available on reasonable request

Declarations

Ethics approval and consent to participate

Declaration of competing interests

Study principles were approved by Necmettin Erbakan University, Meram Faculty of Medicine Local Ethics Committee (Decision number: 2021/3120), written permission from Meram Medical Faculty Hospital Chief Physician, and informed consent form from the participants were obtained for the study.

Consent for publication

Not applicable.

Competing interests

All authors declare that they have no conflicts of interest to disclose.

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