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Bir Tıp Fakültesi Hastanesinde Ziyaretçilere Açık Alanlarda İç Ortam Hava Kalitesinin Ölçülmesi ve Coğrafi Bilgi Sistemi (CBS) ile Haritalanması

Esra ÇİÇEK [1*] Hasan KÜÇÜKKENDİRCİ [2] Yasemin DURDURAN [2]
Süleyman Savaş DURDURAN [3] Tansu ALKAN İLÇİN [4]

[1] Konya Provincial Directorate of Health, Konya, Türkiye
[2] Necmettin Erbakan University, Faculty of Medicine, Department of Public Health, Konya, Türkiye
[3] Necmettin Erbakan University, Faculty of Engineering, Department of Geomatics Engineering, Konya, Türkiye
[4] Niğde Ömer Halisdemir University, Faculty of Engineering, Department of Geomatics Engineering, Niğde, Türkiye

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Anahtar Kelimeler:
CBS teknolojisi,
Hastane,
İç ortam hava kalitesi,
Partiküler madde.

ÖZET

Amaç: Bu çalışma, CBS kullanarak hastanenin iç ortam hava kalitesi verilerini haritalamayı amaçlamıştır.
Materyal ve metot: Bu çalışma, bir tıp fakültesi hastanesinin iç ortam hava kalitesi verilerini içeren tanımlayıcı bir çalışmadır. Analizlerde CBS teknolojisi kullanılmıştır.
Bulgular: Yaz mevsiminde, hastanenin bodrum katında yer alan gastroenteroloji polikliniği; zemin katta bulunan kadın hastalıkları ve doğum polikliniği; birinci katta ise göz polikliniği sekreterliği, kardiyoloji polikliniği ile kadın hastalıkları ve doğum giriş alanlarında, sonbahar mevsiminde, bodrum katta yer alan endoskopi ve taş kırma ünitesi; zemin katta beyin ve sinir cerrahisi polikliniği; birinci katta ise kardiyoloji polikliniği, göz polikliniği sekreterliği, röntgen, kulak burun boğaz polikliniği sekreterliği alanlarında, kış mevsiminde, bodrum katta gastroenteroloji polikliniği, endokrinoloji ve metabolizma hastalıkları polikliniği, plastik rekonstrüktif ve estetik cerrahi polikliniği ile endoskopi ve taş kırma ünitesi; zemin katta beyin ve sinir cerrahisi polikliniği; birinci katta ise göz polikliniği sekreterliği, kulak burun boğaz polikliniği sekreterliği, kardiyoloji polikliniği ve kadın hastalıkları ve doğum giriş alanlarında, ilkbahar mevsiminde ise bodrum katta yer alan endoskopi ve taş kırma ünitesinde; zemin katta gebe polikliniği ile beyin ve sinir cerrahisi polikliniğinde; birinci katta ise kulak burun boğaz polikliniği sekreterliği alanlarında PM_{10} değerlerinin yükseldiği tespit edilmiştir.
Sonuç: Hastanedeki iç ortam hava kalitesi parametrelerinden birkaçının standartlara uygun olmadığı görülmüştür.

Measurement of Indoor Air Quality in Visitor Areas of a Medical Faculty Hospital and Mapping with Geographic Information System (GIS)

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ABSTRACT

Objective: This study aimed to map the hospital's indoor air quality data using GIS.
Material and methods: This study is a descriptive study that includes indoor air quality data of a medical faculty hospital. GIS technology was used in the analysis.
Results: In summer, indoor air quality PM_{10} values of the hospital performed in the basement floor of the hospital include gastroenterology polyclinic; gynecology and obstetrics polyclinic on the ground floor; eye polyclinic secretariat, cardiology polyclinic, gynecology and obstetrics entrance areas on the first floor: in autumn, basement floor of the hospital include endoscopy and kidney stone crushing unit; brain and nerve surgery polyclinic on the ground floor; cardiology polyclinic, eye polyclinic secretariat, X-ray, ear nose and throat polyclinic secretariat areas on the first floor: in winter, basement floor of the hospital include gastroenterology polyclinic, endocrinology and metabolic diseases outpatient clinic, plastic reconstructive and aesthetic surgery polyclinic, endoscopy and kidney stone crushing unit; brain and nerve surgery polyclinic on the ground floor; eye polyclinic secretariat, ear nose and throat polyclinic secretariat, cardiology polyclinic, gynecology and obstetrics entrance areas on the first floor: in the spring, the PM value increases in the endoscopy and kidney stone crushing unit on the basement floor; pregnant polyclinic, brain and nerve surgery polyclinic on the ground floor; the ear nose and throat polyclinic secretariat areas on the first floor.
Conclusion: It was observed that a few of the indoor air quality parameters in the hospital did not comply with the standards.

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***Corresponding Author:** Esra Çiçek, *esracicekakademik@gmail.com*

INTRODUCTION

According to the World Health Organization, 3.2 million people die each year from diseases related to indoor air pollution [1]. Major indoor air pollutants include NOx, volatile and semi-volatile organic compounds, SO_2, O_3, CO, particulate matter, radon, toxic metals and microorganisms [2]. Particulate matter is a complex mixture of solid or liquid particles suspended in the air, which can vary in size, shape and composition. The Environmental Protection Agency specifically states that particles 10 microns in diameter or smaller can be inhaled [3]. The World Health Organization has reported daily average limit values of 50 $\mu g/m^3$ and 25 $\mu g/m^3$ for PM_{10} and $PM_{2.5}$ [4]. In Turkey, only PM_{10} is included in the calculation of air quality index [5].

People spend about 90% of their time indoors, either at home or at work [6]. Indoor air quality refers to the air quality in and around buildings and structures, particularly in relation to the health and comfort of occupants. To reduce the risk of health problems indoors, it is important to know and control common indoor air pollutants. The health effects of indoor air pollutants can occur shortly after exposure or years later. Some health effects, such as eye irritation, rhinitis, wheezing in the throat, headache, dizziness and fatigue, occur shortly after a single or repeated exposure to a pollutant and are usually treated [7-12]. Some health effects, such as respiratory diseases, heart disease and cancer, occur years after exposure to a pollutant or only after long or repeated periods of exposure [13-15]. Improving indoor air quality indoors is crucial for health, even if these symptoms go unnoticed [16].

In studies on air quality, computer-aided geographic information systems (GIS) technology is generally used in data collection, storage, analysis and visualization [17,18]. For example, it was used for visualization of PM_{10} and SO_2 air quality distribution maps in the winter season of the Marmara region in 2015-2016, for temporal and spatial modeling of PM concentration in a neighborhood in Konya, and for spatiotemporal mapping of air pollution risk areas using PM_{10} and SO_2 air quality parameters in Kocaeli between 2021-2022 [19-21].

While the primary purpose of hospitals is to promote, improve or maintain health for all, they are also high-risk areas. They have a high density and a high number of users, with many different activities and a diversity of health conditions [22]. Indoor air quality in hospitals is a significant risk factor due to the presence of pollutants, which are often present in higher concentrations than in other indoor environments. In addition, hospitals provide round the clock services and therefore do not have free time to recover from emissions and the resulting impact on indoor air quality. It is therefore very important to develop various strategies for controlling and improving indoor air quality. In this study, it is aimed to map the indoor air quality measurement data of four seasons in a medical faculty hospital with GIS technology.

MATERIAL AND METHODS

This study is a descriptive study. The study was conducted in a medical faculty hospital in Konya province during the summer, fall and winter seasons of 2023 and spring seasons of 2024. Data were obtained by indoor air quality measurements in the basement, ground and first floors of the hospital.

Indoor air quality measurements were made in the basement (women's masjid, endoscopy entrance, endoscopy, kidney stone crushing unit, under the stairs, elevator, report center, gastroenterology polyclinic, plastic, reconstructive and aesthetic surgery polyclinic, endocrinology and metabolic diseases outpatient clinic, ECG front, toilet), ground floor (cashier front, near hospital entrance, under the stairs, pregnancy polyclinic, brain and nerve surgery polyclinic, blood collection unit, gynecology and obstetrics polyclinic, opposite elevator, adult immunology and allergy diseases outpatient clinic, family medicine polyclinic, opposite cashier, back of security) and first floor (cardiology polyclinic, ECG front, gynecology and obstetrics entrance, elevator front, X-ray, breast USG, blood center, stair exit, ear nose and throat polyclinic secretariat, eye polyclinic secretariat, between the stairs, ultrasound) of the hospital.

Data collection

With the particulate matter meter, data were collected instantaneously at the research points including four seasons (summer of 2023, fall, winter and spring of 2024) during working hours on weekdays, before noon (8.00-12.00), lunch break (12.00-13.15) and afternoon (13.15-17.00) on a day convenient for the researcher. At the research points, the measurement process was carried out by holding the PM meter at a height of 1 meter above the ground.

Data can be displayed numerically with the “Particle Counter PCE-PCO1”, a laser particle counter and dust meter configured to determine the concentration of particles in the air. This device is used to monitor dust levels in rooms, indoor air quality, exposure to exhaust, tobacco or cigarette smoke and other harmful air pollutants. The device measures 6 different particle sizes (0.3 µm, 0.5 µm, 1.0 µm, 2.5 µm, 5.0 µm, 10 µm) and stores more than 5000 measurements in internal memory. This device, which is suitable for taking measurements at different points in terms of easy portability, is charged before going to the measurement site and is calibrated and zeroed in a dust free standard environment before measurement.

Data Analysis

Geographic Information System technology was used to spatial analysis the data. Averages of the points where indoor air quality measurements were made in the hospital during four seasons (three measurement values before noon, lunch break and afternoon) were taken, and then distribution maps for each parameter ($PM_{2.5}$ and PM_{10}) were created using the inverse distance weighted interpolation method (IDW). In the maps, the legend shows the value ranges represented by the colors and the particulate matter values increase from blue to red.

RESULTS

The findings of the study are presented according to seasons.

Summer season

$PM_{2.5}$ and PM_{10} values of indoor air quality in the basement of the hospital increase in under the stairs, elevator, women's masjid, toilet, report center and gastroenterology polyclinic areas. $PM_{2.5}$ and PM_{10} values decrease in ECG front, endocrinology and metabolic disease outpatient clinic, plastic, reconstructive and aesthetic surgery polyclinic, endoscopy, endoscopy entrance and kidney stone crushing unit. The minimum and maximum value ranges of indoor air quality in the basement of the hospital during the summer season were 355-554 µg/m^3 for $PM_{2.5}$ and 43-69 µg/m^3 for PM_{10} (Figure 1a-1b).

In the indoor air quality $PM_{2.5}$ measurement made on the ground floor of the hospital, the PM value increases in the areas near hospital entrance, back of security, cashier front, opposite cashier, brain and nerve surgery polyclinic. In PM_{10} measurement, PM value increases in the areas near hospital entrance, cashier front, opposite cashier, blood collection unit, gynecology and obstetrics polyclinic. $PM_{2.5}$ value decreases in the areas of pregnant polyclinic, opposite elavator, adult immunology and allergy diseases polyclinic, family medicine polyclinic, under the stairs, blood collection unit, gynecology and obstetrics polyclinic. PM_{10} value decreases in pregnant polyclinic, opposite elavator, adult immunology and allergy diseases outpatient clinic, family medicine outpatient clinic, under the stairs, back of security, brain and nerve surgery polyclinic. In the ground floor of the hospital during the summer season, the $PM_{2.5}$ value was 330-590 µg/m^3, while the PM_{10} value was 40-77 µg/m^3 (Figure 2a-2b).

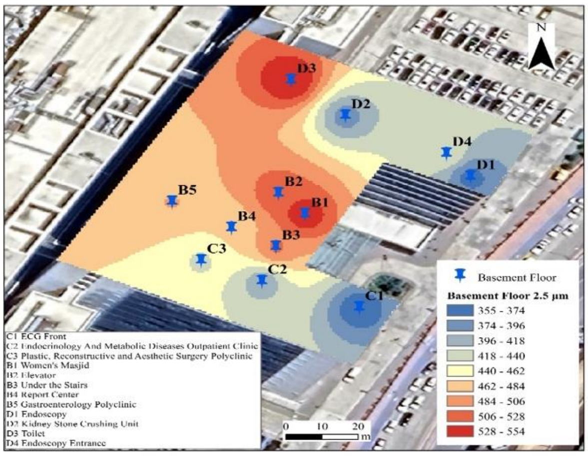

Figure 1a
$PM_{2.5}$ in the basement of the hospital in summer.

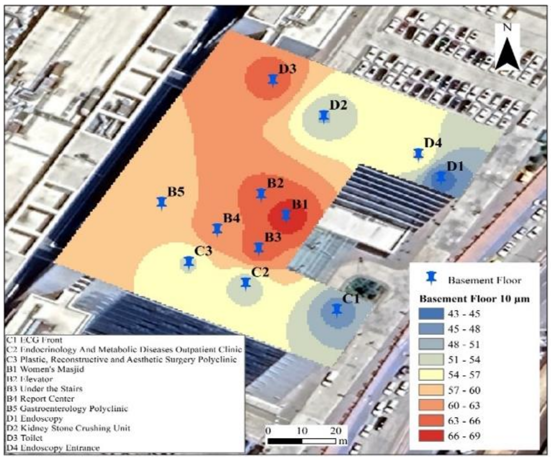

Figure 1b
PM_{10} in the basement of the hospital in summer.

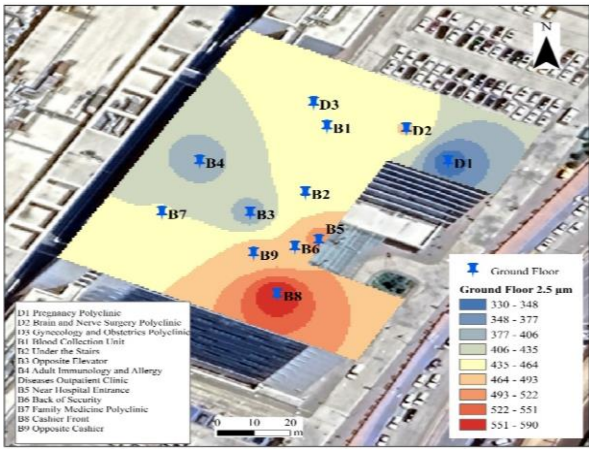

Figure 2a
$PM_{2.5}$ on the ground floor of the hospital in summer.

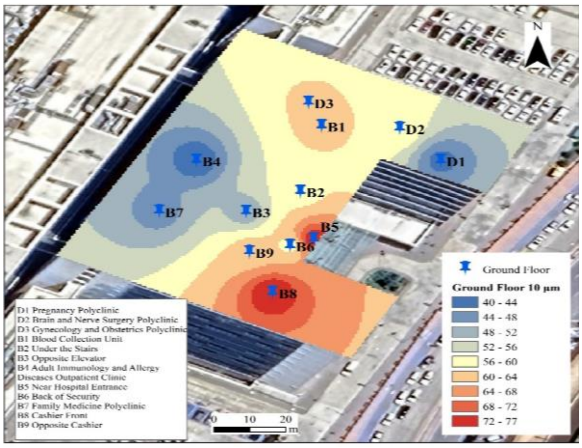

Figure 2b
PM_{10} on the ground floor of the hospital in summer.

In the indoor air quality $PM_{2.5}$ measurement made on the first floor of the hospital, the PM value increases in the areas between the stairs, stair exit, ECG front, eye polyclinic secretariat, gynecology and obstetrics entrance, blood center and cardiology polyclinic. In PM_{10} measurement, PM value increases between the stairs, stair exit, ECG front, eye polyclinic secretariat, cardiology polyclinic, gynecology and obstetrics entrance. $PM_{2.5}$ value decreases in the ear, nose and throat polyclinic secretariat, elevator front, X-ray, ultrasound and breast USG areas. PM_{10} value decreases in the ear, nose and throat polyclinic secretariat, elevator front, X-ray, ultrasound, breast USG and blood center areas. On the first floor of the hospital during the summer season, the $PM_{2.5}$ value was 269-541 µg/m^3, while the PM_{10} value was 36-75 µg/m^3 (Figure 3a-3b).

Autumn season

In the indoor air quality $PM_{2.5}$ measurement made in the basement of the hospital, PM value increases in under the stairs, elevator, women's masjid, report center, endoscopy, endoscopy entrance, toilet and kidney stone crushing unit areas. In PM_{10} measurement, PM value increases in under the stairs, elevator, women's masjid, report center, endoscopy, endoscopy entrance and kidney stone crushing unit. $PM_{2.5}$ value decreases in ECG front, endocrinology and metabolic disease outpatient clinic, plastic, reconstructive and aesthetic surgery polyclinic and gastroenterology polyclinic. PM_{10} value PM value decreases in ECG front, endocrinology and metabolic disease outpatient clinic, plastic, reconstructive and aesthetic surgery polyclinic, gastroenterology polyclinic and toilet areas. The minimum and maximum value ranges of indoor air quality in the basement of the hospital in the fall season were 551-1031 µg/m^3 for $PM_{2.5}$ and 45-87 µg/m^3 for PM_{10} (Figure 4a-4b).

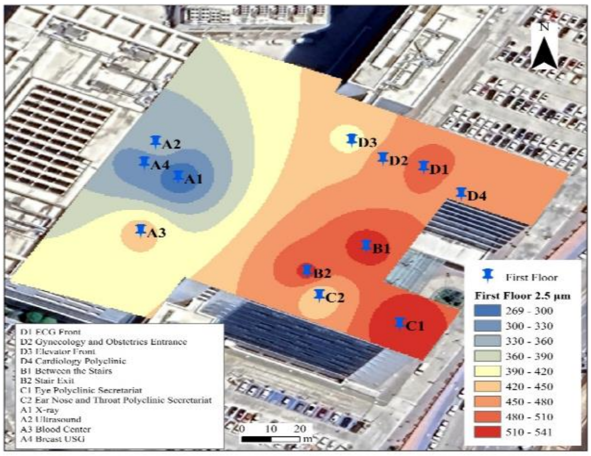

Figure 3a
$PM_{2.5}$ on the first floor of the hospital in summer.

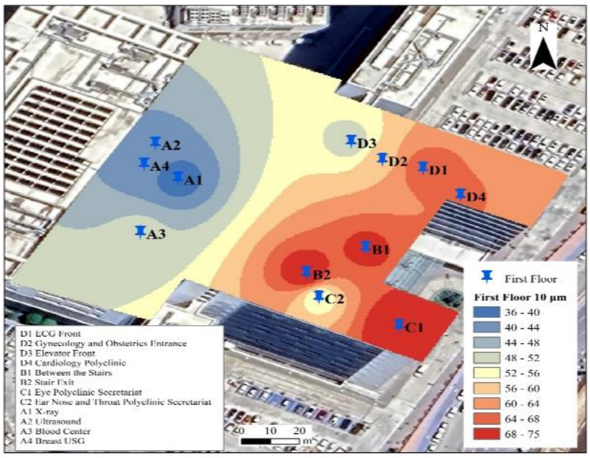

Figure 3b
PM_{10} on the first floor of the hospital in summer.

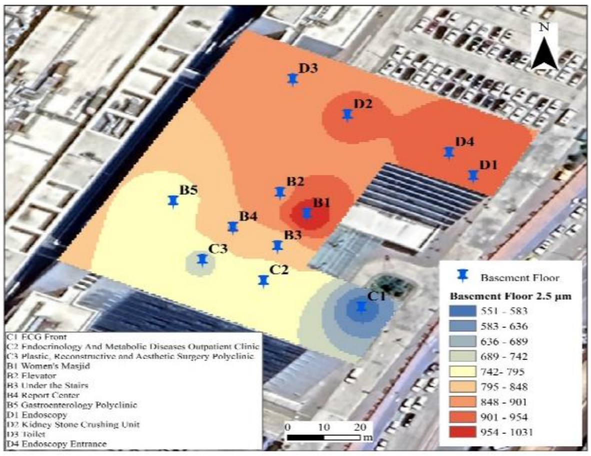

Figure 4a
$PM_{2.5}$ in the basement of the hospital in the fall season.

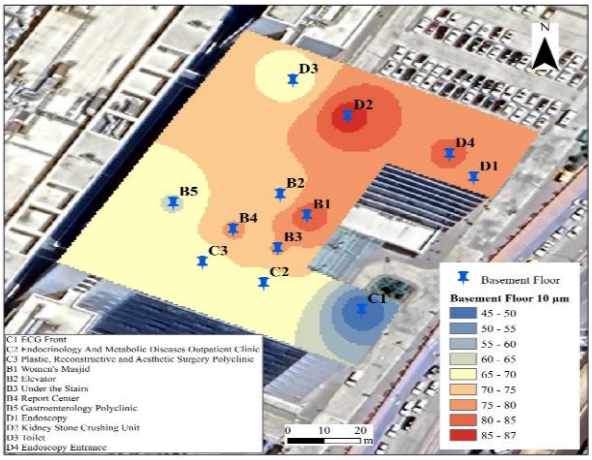

Figure 4b
PM_{10} in the basement of the hospital in the fall season.

In both $PM_{2.5}$ and PM_{10} measurements of indoor air quality on the ground floor of the hospital, PM value increases in near hospital entrance, under the stairs, cashier front, blood collection unit, brain and nerve surgery polyclinic. $PM_{2.5}$ and PM_{10} values decrease in pregnancy polyclinic, gynecology and obstetrics polyclinic, back of security, opposite cashier, opposite elevator, adult immunology and allergy disease outpatient clinic and family medicine polyclinic. In the fall season, $PM_{2.5}$ was 372-951 µg/m^3 in the ground floor of the hospital, while PM_{10} was 37-83 µg/m^3 (Figure 5a-5b).

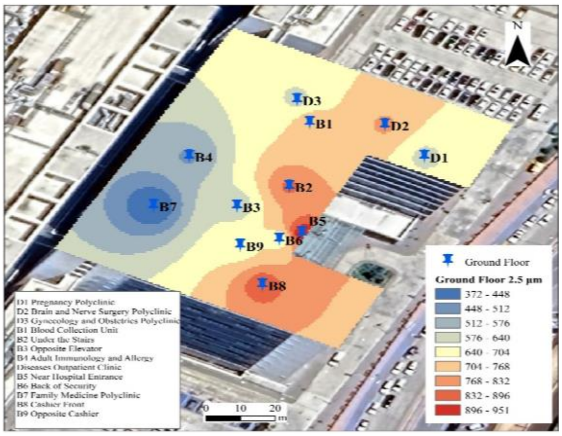

Figure 5a
PM2.5 on the ground floor of the hospital in the fall season.

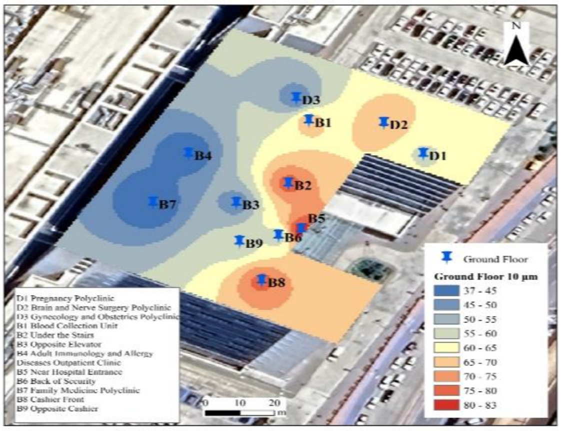

Figure 5b
PM10 on the ground floor of the hospital in the fall season.

In the indoor air quality $PM_{2.5}$ measurement made on the first floor of the hospital, PM value increases in ECG front, gynaecology and obstetrics entrance, elevator front, cardiology polyclinic, X-ray, breast USG, ear nose and throat polyclinic secretariat areas. In PM_{10} measurement, PM value increases in ECG front, elevator front, cardiology polyclinic, between the stairs, eye polyclinic secretariat, X-ray, ear nose and throat polyclinic secretariat. $PM_{2.5}$ value decreases in ultrasound, blood center, between the stairs, stair exit and eye polyclinic secretariat areas. PM_{10} value decreases in ultrasound, breast USG, blood center, stair exit, gynecology and obstetrics entrance areas. In the fall season, the $PM_{2.5}$ on the first floor of the hospital was 382-521 µg/m^3, while the PM_{10} was 32-51 µg/m^3 (Figure 6a-6b).

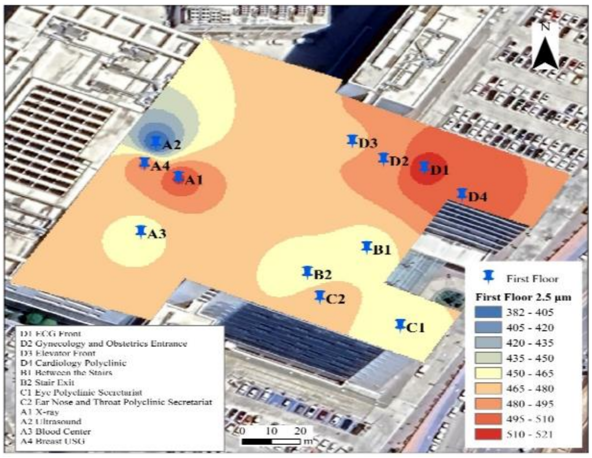

Figure 6a
PM2.5 on the first floor of the hospital in the fall season.

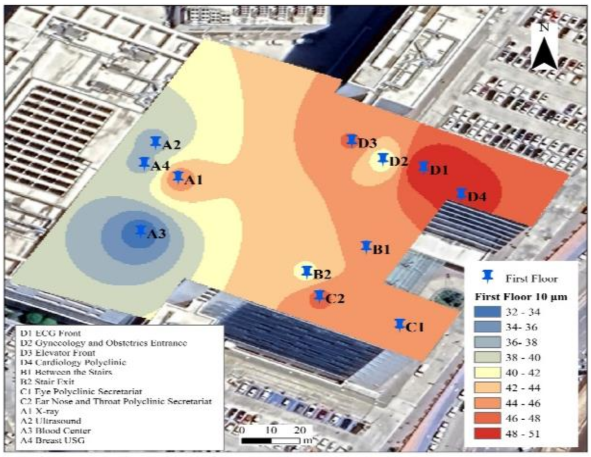

Figure 6b
PM10 on the first floor of the hospital in the fall season.

Winter season

In the indoor air quality $PM_{2.5}$ measurement made in the basement of the hospital, PM value increases in under the stairs, elevator, women's masjid, report center, endocrinology and metabolic diseases outpatient clinic, gastroenterology polyclinic, endoscopy, endoscopy entrance and kidney stone crushing unit. In PM_{10} measurement, PM value increases in under the stairs, elevator, women's masjid, report center, gastroenterology polyclinic, endocrinology and metabolic diseases outpatient clinic, plastic reconstructive and aesthetic surgery polyclinic, endoscopy, endoscopy entrance, toilet and kidney stone crushing unit. $PM_{2.5}$ value decreases in ECG front, plastic, reconstructive and aesthetic surgery polyclinic and toilet areas. PM_{10} value decreases in ECG front area. The minimum and maximum value ranges of indoor air quality in the basement of the hospital during the winter season were 401-800 µg/m^3

for $PM_{2.5}$ and 43-67 µg/m^3 for PM_{10} (Figure 7a-7b).

In both $PM_{2.5}$ and PM_{10} measurements made on the ground floor of the hospital, the PM value increases in the areas near hospital entrance, under the stairs, back of security, cashier front, opposite cashier, blood collection unit, brain and nerve polyclinic. $PM_{2.5}$ and PM_{10} values decrease in pregnant polyclinic, gynecology and obstetrics outpatient clinic, opposite elevator, adult immunology and allergy diseases outpatient clinic and family medicine polyclinic. In winter, $PM_{2.5}$ was 355-998 µg/m^3 in the ground floor of the hospital, while PM_{10} was 26-87 µg/m^3 (Figure 8a-8b).

In the indoor air quality $PM_{2.5}$ measurement made on the first floor of the hospital, PM value increases in between the stairs, stair exit, eye polyclinic secretariat, ear nose and throat polyclinic secretariat, ECG front, cardiology polyclinic and blood center areas. In PM_{10} measurement, PM value increases in between the stairs, stair exit, eye polyclinic secretariat, ear nose and throat polyclinic secretariat, ECG front, cardiology polyclinic, gynecology and obstetrics entrance. $PM_{2.5}$ decreases in gynecology and obstetrics entrance, elevator front, X-ray, ultrasound and breast USG areas. PM_{10} value

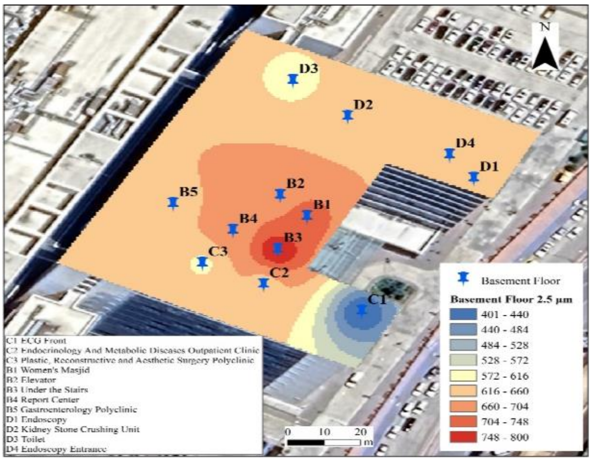

Figure 7a
$PM_{2.5}$ in the basement of the hospital in winter.

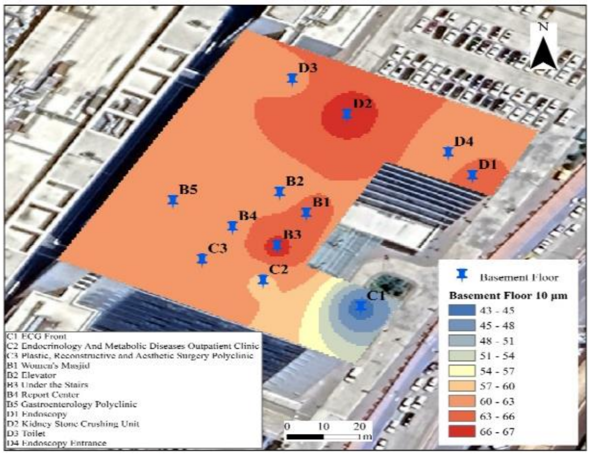

Figure 7b
PM_{10} in the basement of the hospital in winter.

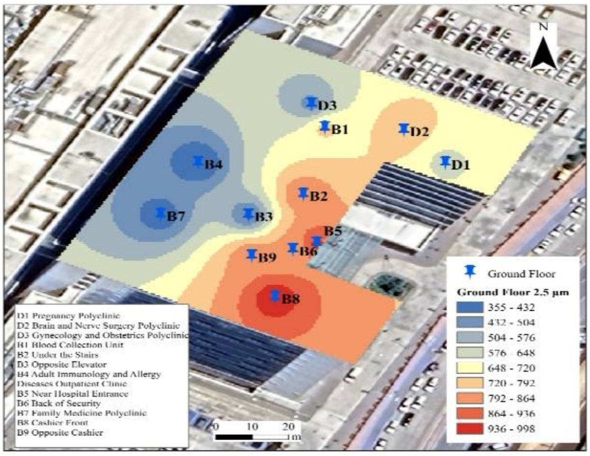

Figure 8a
$PM_{2.5}$ on the ground floor of the hospital in winter.

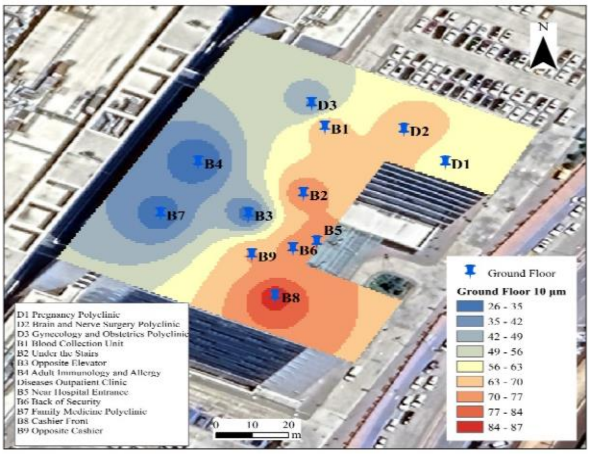

Figure 8b
PM_{10} on the ground floor of the hospital in winter.

decreases in elevator front, blood center, X-ray, ultrasound and breast USG areas. In the winter season, $PM_{2.5}$ on the first floor of the hospital was 256-715 µg/m^3, while PM_{10} was 22-58 µg/m^3 (Figure 9a-9b).

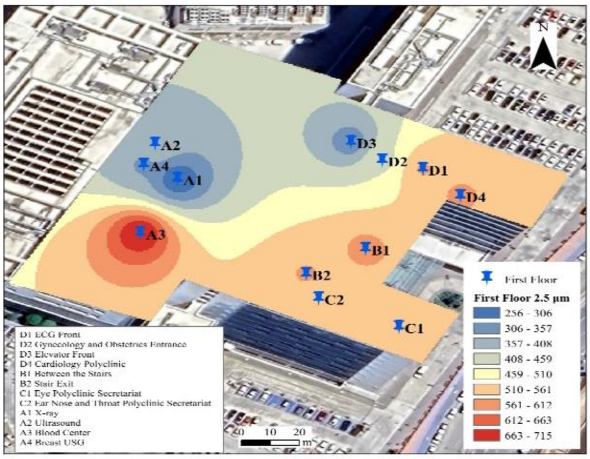

Figure 9a
$PM_{2.5}$ on the first floor of the hospital in winter.

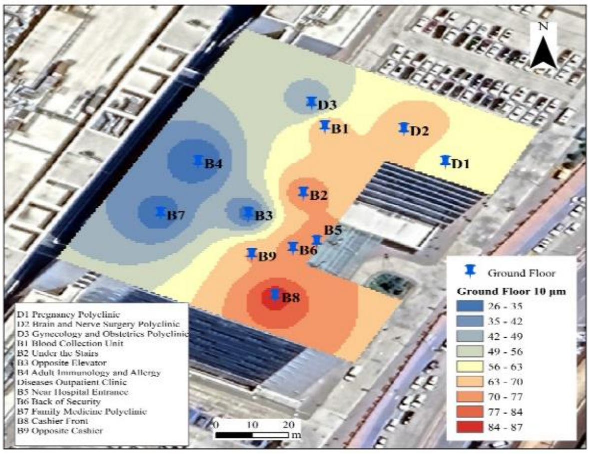

Figure 9b
PM_{10} on the first floor of the hospital in winter.

Spring season

In the indoor air quality $PM_{2.5}$ measurement in the basement of the hospital, PM value increases in women's masjid, elevator, under the stairs, report center, gastroenterology polyclinic, plastic, reconstructive and aesthetic surgery polyclinic, endoscopy, endoscopy entrance, toilet and kidney stone crushing unit. In PM_{10} measurement, PM value increases in women's masjid, elevator, report center, endoscopy and kidney stone crushing unit areas. $PM_{2.5}$ value decreases in ECG front, endocrinology and metabolic disease outpatient clinic. PM_{10} decreases in ECG front, endocrinology and metabolic disease outpatient clinic, under the stairs, plastic, reconstructive and aesthetic surgery polyclinic, gastroenterology polyclinic, toilet and endoscopy entrance. The minimum and maximum value ranges of indoor air quality in the basement of the hospital in the spring season were 495-947 µg/m^3 for $PM_{2.5}$ and 47-85 µg/m^3 for PM_{10} (Figure 10a-10b).

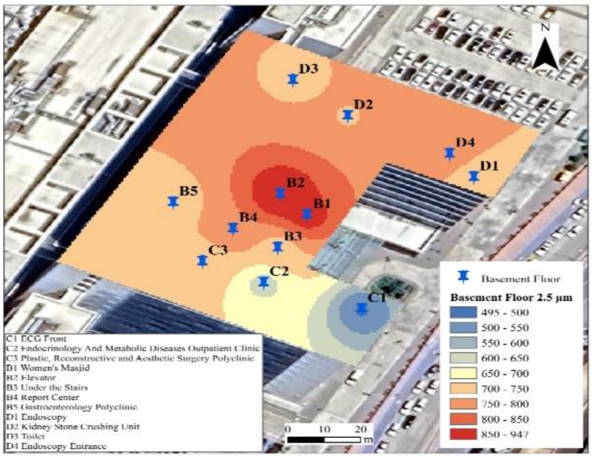

Figure 10a
$PM_{2.5}$ value in the basement of the hospital in spring season.

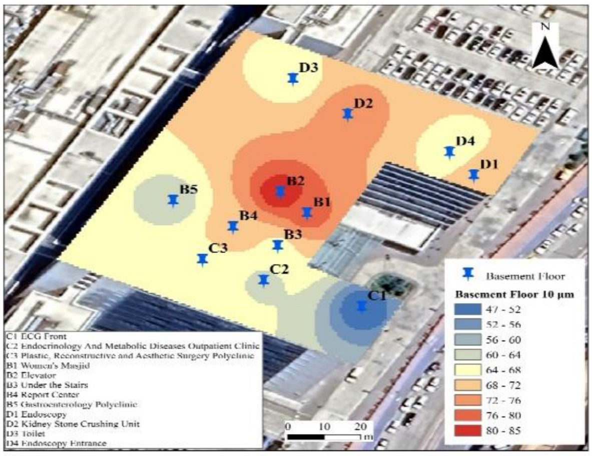

Figure 10b
PM_{10} value in the basement of the hospital in spring season.

In the indoor air quality $PM_{2.5}$ measurement made on the ground floor of the hospital, the PM value increases in the areas near hospital entrance, back of security, cashier front, opposite cashier, under the stairs, blood collection unit, brain and nerve surgery polyclinic. In the measurement of PM_{10}, the PM value increases in the areas near hospital entrance, back of security, cashier front, opposite cashier, under the stairs, blood collection unit, pregnant polyclinic, brain and nerve surgery polyclinic. $PM_{2.5}$ value decreases in the areas of pregnant polyclinic, gynecology and obstetrics polyclinic, opposite elevator, adult immunology and allergy diseases polyclinic and family medicine polyclinic. PM_{10} value decreases in gynecology and obstetrics outpatient clinic, opposite elevator, adult immunology and allergy diseases outpatient clinic and family medicine outpatient clinic areas. In the spring season, the $PM_{2.5}$ value on the ground floor of the hospital was 418-959 µg/m^3, while the PM_{10} value was 29-74 µg/m^3 (Figure 11a-11b).

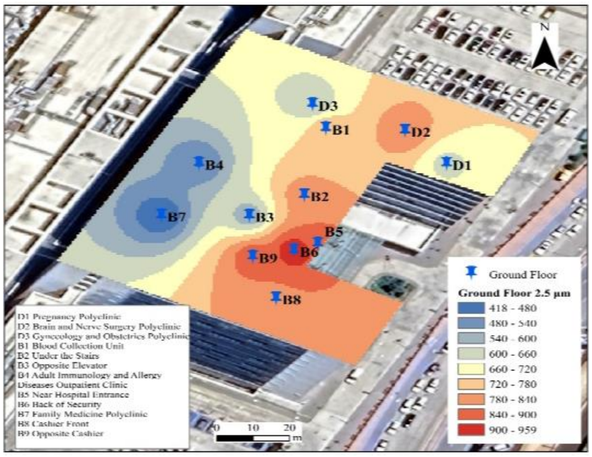

Figure 11a
$PM_{2.5}$ on the ground floor of the hospital in spring season.

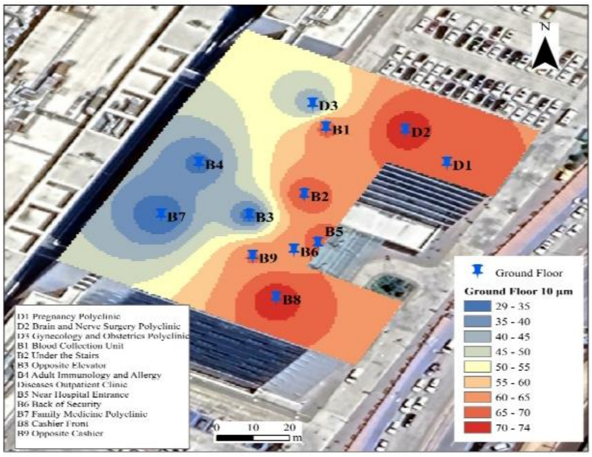

Figure 11b
PM_{10} on the ground floor of the hospital in spring season.

In the indoor air quality $PM_{2.5}$ measurement made on the first floor of the hospital the PM value increases in the blood center area. In PM_{10} measurement, PM value increases in between the stairs, stair exit, ear nose and throat polyclinic secretariat, ECG front and blood center areas. $PM_{2.5}$ decreases in eye polyclinic, ear nose and throat polyclinic secretariat, between the stairs, stair exit, X-ray, ultrasound, breast USG, ECG front, gynecology and obstetrics entrance, elevator front and cardiology polyclinic. PM_{10} value decreases in eye polyclinic, X-ray, ultrasound, breast USG, gynecology and obstetrics entrance, elevator front and cardiology policlinic areas. In the spring season, 372-1200 µg/m^3 in $PM_{2.5}$ and 25-69 µg/m^3 in PM_{10} were found on the first floor of the hospital (Figure 12a-12b).

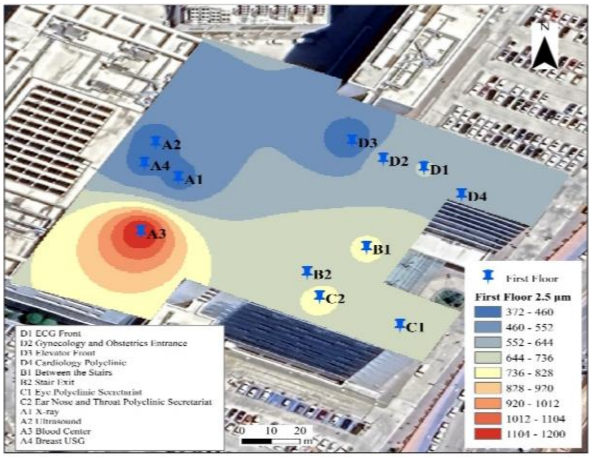

Figure 12a
$PM_{2.5}$ on the first floor of the hospital in spring season.

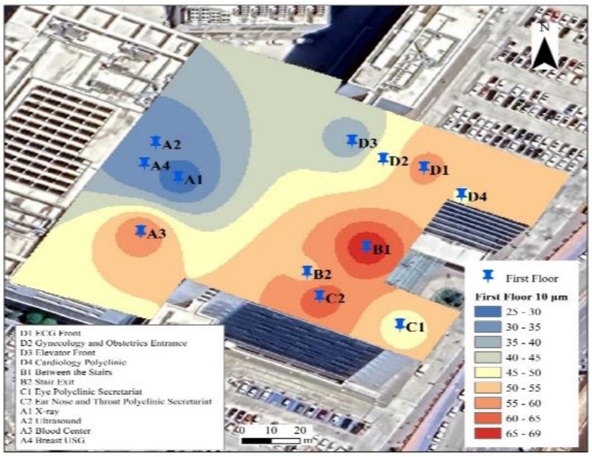

Figure 12b
PM_{10} on the first floor of the hospital in spring season.

DISCUSSION AND CONCLUSION

In our research, it was observed that indoor air quality on the floors of the hospital varies according to both outpatient clinics and seasons. $PM_{2.5}$ and PM_{10} distribution maps were created and it was determined that the PM value increased as the value ranges represented by the colors in the legend went from blue to red. In this study, indoor air quality measurement data of four seasons in a medical faculty hospital were mapped with GIS technology.

Indoor air quality in hospitals is of paramount importance, with significant impacts on patient well-being, staff productivity and overall health outcomes [23]. In a study examining the indoor air quality of hospitals in Bangladesh, it was observed that $PM_{2.5}$ and PM_{10} values had very high indoor toxicity potential values in winter [24]. In a study examining indoor air quality in a hospital in Şanlıurfa province, the average concentration of $PM_{2.5}$ was found to be 9.65µg/m^3 in X-ray and 45.7µg/m^3 in neurology outpatient clinics. PM_{10} values were 18.55 µg/m^3 and 84.48 µg/m^3 in pathology and neurology outpatient clinics, respectively [25]. Some non-hospital studies have found similar situations. In a study examining indoor air quality in government offices in Nigeria during the rainy and dry seasons, it was found that there was an increase in pollutant concentrations during the dry season, leading to a lower air quality index compared to the rainy season [26]. Again, in a study examining $PM_{2.5}$ levels according to seasons in a shopping center in Konya province, it was reported that the measured value exceeded WHO standards and was lower in summer than in winter [27]. In a study examining the effects of dust particles on indoor air quality in the Sarı Konak, rectorate, faculty of economics and administrative sciences and central cafeteria buildings of a university, indoor air pollution was found to be higher than outdoor air pollution [28]. In a study examining indoor air quality in residential buildings in Egypt, it was found that indoor daily averages of PM_{10} and $PM_{2.5}$ concentrations in all selected houses were higher than the limit values in WHO guidelines [29].

This article focuses on the sociopsychological implications of measuring indoor air quality in public spaces, which impacts quality of life. This study is valuable in making hospital environments comfortable for patients and visitors. It was observed that a few of the indoor air quality parameters in the hospital did not comply with the standards. The new university hospital campus, which has been operating in Konya since 1982, boasts advanced technology and equipment, along with adequate ventilation. However, with a capacity of 1.350 beds, 3.233 healthcare workers, and a 200.000 m² indoor area, the new hospital campus offers services in six blocks and the old campus in ten blocks. Smoking is strictly forbidden and frequent cleanings are done during the day. The excessive number of patients coming to the hospital and the crowding may have affected our results. A study examining indoor air quality in hospitals by work area found that people walking indoors could affect the level of PM in the air [30]. Indoor air data studies conducted at a hospital in China reported that high hospital occupancy rates generally lead to high indoor PM 2.5 and PM 10 episodes [31]. Therefore, indoor air quality values should be measured at regular intervals and brought into compliance with the standards.

As a result, the fact that the data includes four seasons and can be mapped with GIS is an advantage of the study, while the fact that PM values are collected instantaneously at the study points and do not include twenty-four hours is a limitation. In our country, studies in which hospital indoor air quality is measured and mapped are limited. Therefore, it is thought that such studies will make an important contribution to the field of health.

Ethical Statement

Necmettin Erbakan University Drug and Non-Medical Device Research Ethics Committee's approval was obtained on September 15, 2023, decision no: 2023/4525. Later, due to the addition, subtraction and title change of researchers, ethics committee approval was obtained from Necmettin Erbakan University Pharmaceutical and Non-Medical Device Research Ethics Committee on July 19, 2024, decision no: 2024/5120.

Author Contributions

Research Design (CRediT 1) E.Ç. (%70) – H.K. (%30)
Data Collection (CRediT 2) E.Ç. (%70) – H.K. (%30)
Research - Data Analysis - Validation (CRediT 3-4-6-11) T.A. (%70) – S.S.D. (%30)
Writing the Article (CRediT 12-13) E.Ç. (%60) – H.K. (%10) – Y.D. (%10) – S.S.D. (%10) – T.A. (%10)
Revision and Improvement of the Text (CRediT 14) E.Ç. (%60) – H.K. (%10) – Y.D. (%10) – S.S.D. (%10) – T.A. (%10)

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Conflict of Interest

The authors report no declarations of interest.

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Sustainable Development Goals (SDG)

Sustainable Development Goals: 12 Responsible Consumption and Production (12a and 12b).

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