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# Determination of Environmental Noise Contamination

O. GÜNAY<sup>\*</sup>, O. YARAR AND M. SARIHAN

Istanbul Okan University, Vocational School of Health Services, Istanbul, Turkey

Noise pollution — one of the major environmental problems, affects people both physiologically and psychologically. Noise measurements must be carried out regularly to overcome the noise problem. The study in this paper was conducted to determine the noise level in different parts of an education and research hospital in Istanbul. Noise levels were measured at the main entrance, pediatric department, emergency room entrance, audiology clinic, nuclear medicine cardiology clinic, eye clinic, and emergency service corridor of the hospital. Measurements were taken on Monday, Tuesday, Wednesday, Thursday, and Friday, every hour from 08:00 in the morning to 17:00 in the afternoon. As a result, average noise levels were found between 52 dB and 57 dB in different parts of the hospital. The results were compared with similar studies and recommendation in WHO guidelines.

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## 1. Introduction

There are many environmental problems that affect people [1]. Some of these environmental problems are soil pollution, air pollution, water pollution, radiation pollution, and noise pollution [2–5]. Several studies have been conducted to determine the levels of these environmental problems [6–7].

Noise can be defined as disturbing sounds to the human ears. The intensity of noise is measured in decibels (dB) and is referred as a function of the sound pressure. The level of environmental noise increased after the industrial revolution, in particular, with a significant increase in mechanization. In all environments where people live, such as schools, workplaces, homes, and hospitals, there is a certain level of noise.

Development of technology caused that there appeared the number of electronic devices used in the hospital. Noise from these devices is damaging for both the patients and the employees. The noise sources in hospitals are very diverse. There are two effective factors that influence this noise level. One of them are all sources of hospital noise. The second is the environmental physiology of the hospital. The major noise sources in the hospital are personnel voices, alarms, announcements, telephone rings, paging systems, pneumatic tubes, patient voices, and cars (emergency cars, washing cars, stretchers, and other material carriers). Environmental physiology, in turn, includes the surfaces surrounding the hospital, walls, floors, and ceilings. Acoustic conditions in these environments increase the noise level as well.

For the patients exposed to noise in hospitals, the resulting problems are, e.g., an increased heart rate, metabolism and oxygen consumption, anxiety, and pain perception, increased corticosteroid release, and decreased respiratory function [8–10]. Other important problems related to noise in patients are sleep disorder and stress and intensive care psychosis [11]. In addition, anxiety, irritability, trial disturbance, changes in perception, and concentration difficulties are observed in the personnel exposed to noise. This may lead to impaired mental abilities and a decrease in job performance [12]. One of the negative effects of noise in hospitals is that they cause splits and errors in medical treatment processes.

A quiet, calm, and pleasant environment in hospitals can benefit both health personnel and patients. Health personnel working in a quiet environment will be physiologically and psychologically healthier. Thus, they will contribute to faster recovery of patients. Therefore, determining the noise level in hospitals is very important for both sides. In this study, the aim was to determine noise levels in different departments of a university hospital.

## 2. Materials and methods

This study was carried out in Istanbul Okan University Research and Application Hospital which was opened in 2014. It was established on a 50000 m<sup>2</sup> closed area. It serves as a fully equipped general hospital with more than 500 employees and lecturers, 250 bed capacity, 10 operating rooms, intensive care unit with 47 beds, and technological infrastructure. The distance of the hospital to the main road is 200 m (Fig. 1).

Noise levels were measured at the main entrance, pediatric department, emergency room entrance, audiology clinic, nuclear medicine cardiology clinic, eye clinic, and emergency service corridor of the hospital. Measurements were performed on Monday, Tuesday, Wednesday, Thursday, and Friday, taken in every hour from 08:00 in the morning to 17:00 in the afternoon.

<sup>\*</sup>corresponding author; e-mail: osman.gunay@okan.edu.tr



Fig. 1. Studying Area (Istanbul Okan University Hospital).

We used the device with the CEM Mark, DT-805 Model. The integrated mean was obtained with

$$LA_{eq} = 10 \log_{10} \left( \frac{1}{n_j} \sum_{i=1}^n 10^{L_e q_i j/10} \right),$$

where i corresponds to observation of the A-weighted equivalent continuous level reported in the hourly interval j, and n is the total number of i observations in the j hour [7].

### 3. Results and discussion

On Monday, the lowest noise level was found to be 53.04 dB at 17:00, while the highest noise level was 66.12 dB at 10:00. The average noise level in main entrance of the hospital was equal 60.12 dB. On Tuesday, the lowest noise level was found to be 52.02 dB at 17:00, while the highest noise level was 66.91 dB at 12:00, while and the average noise level was 60.29 dB. On Wednesday, the lowest noise level was found to be 54.78 dB at 16:00, while the highest noise level of 62.15 dB was at 08:00. The average noise level was 58.61 dB. On Thursday, the lowest noise level was found to be 53.58 dB at 14:00, while the highest noise level of 63.52 dB was at 08:00, and the average noise level was 57.70 dB. On Friday, the lowest noise level was found to be 52.67 dB at 17:00, while the highest noise level was 63.56 dB at 08:00. The average noise level in main entrance of the hospital was 58.28 dB (Fig. 2).

In case of pediatric department, the lowest noise level on Monday was found to be 53.78 dB at 16:00, while the highest noise level of 61.15 dB was at 08:00. The average noise level was 57.61 dB. On Tuesday, the lowest noise level was found to be 51.92 dB at 17:00, while the highest noise level of 64.41 dB was at 10:00, and thus the average noise value was 58.00 dB. On Wednesday, the lowest noise level was found to be 49.52 dB at 17:00, while the highest noise level equal 64.41 dB was at 12:00. The average noise level was 57.79 dB. On Thursday, the lowest noise level was found to be 51.00 dB at 17:00, while the highest noise level of 64.12 dB was at 10:00, and the average noise level was 58.12 dB. On Friday, the lowest noise level was found to be 50.92 dB at 17:00, while the highest noise level of 58.91 dB was at 09:00. The average noise level was 55.38 dB (Fig. 3).



Fig. 2. The noise level at different days and hours in main entrance of the hospital.



Fig. 3. The noise level at different days and hours in pediatrics department.



Fig. 4. The noise level at different days and hours in emergency room entrance.

In emergency room entrance, the lowest noise level on Monday was found to be 51.45 dB at 17:00, while the highest noise level was 61.45 dB at 13:00 and the average noise level was 56.37 dB. On Tuesday, the lowest noise level was found to be 50.35 dB at 14:00, while the highest noise level was 62.11 dB at 09:00 and the average noise level was 56.93 dB. On Wednesday, the lowest noise level was found to be 52.69 dB at 16:00, while the highest noise level was 60.25 dB at 10:00 and the average noise level was 56.43 dB. On Thursday, the lowest noise level was found to be 50.12 dB at 16:00, while



Fig. 5. The noise level at different days and hours in audiology clinic.



Fig. 6. Noise level at different days and hours in nuclear medicine.

the highest noise level was 61.57 dB at 10:00 and the average noise level was 56.20 dB. On Friday, the lowest noise level was found to be 50.56 dB at 16:00, while the highest noise level was 59.00 dB at 13:00. The average noise level in emergency room entrance was 55.26 dB (Fig. 4).

In audiology clinic, the lowest noise level on Monday was found to be 51.39 dB at 08:00, while the highest noise level was 61.61 dB at 14:00. The average noise level was 55.84 dB. On Tuesday, the lowest noise level was found to be 52.33 dB at 08:00, while the highest noise level was 58.53 dB at 11:00, and the average noise level was 55.58 dB. On Wednesday, the lowest noise level was found to be 50.15 dB at 17:00, while the highest noise level was 60.15 dB at 13:00 and the average noise level was 55.07 dB. On Thursday, the lowest noise level was found to be 48.12 dB at 17:00, while the highest noise level was 60.83 dB at 08:00 and the average noise level was 54.91 dB. On Friday, the lowest noise level was found to be 47.75 dB at 14:00, while the highest noise level of 59.51 dB was at 09:00. The average noise level in audiology clinic was 54.33 dB (Fig. 5).

On Monday, the lowest noise level was found to be 48.62 dB at 17:00, while the highest noise level was 61.18 dB at 12:00 and the average noise level was 54.60 dB in nuclear medicine. On Tuesday, the lowest noise level was found to be 52.12 dB at 17:00, while the highest noise level was 62.16 dB at 12:00 and the av-



Fig. 7. The noise level at different days and hours in cardiology clinic.

erage noise level was 57.26 dB. On Wednesday, the lowest noise level was found to be 50.13 dB at 08:00, while the highest noise level was 60.35 dB at 14:00 and the average noise level was 54.58 dB. On Thursday, the lowest noise level was found to be 51.22 dB at 17:00, while the highest noise level was 59.33 dB at 14:00, and the average noise level was 54.72 dB. On Friday, the lowest noise level was found to be 49.13 dB at 08:00, while the highest noise level of 55.33 dB was at 14:00. The average noise level in nuclear medicine was 52.38 dB (Fig. 6).

On Monday, the lowest noise level was found to be 47.59 dB at 17:00. The highest noise level was 60.11 dB at 10:00 and the average noise level was 53.28 dB in cardiology clinic. On Tuesday, the lowest noise level was found to be 49.29 dB at 15:00. The highest noise level was 60.76 dB at 09:00 and the average noise level was 54.30 dB. On Wednesday, the lowest noise level was found to be 46.52 dB at 17:00, while the highest noise level of 59.08 dB was at 12:00 and the average noise level was 52.50 dB. On Thursday, the lowest noise level was found to be 48.92 dB at 17:00. The highest noise level was 58.93 dB at 09:00. The average noise level was 54.06 dB. On Friday, the lowest noise level was found to be 45.96 dB at 17:00, while the highest noise level of 57.18 dB was at 09:00. The average noise level in cardiology clinic was 53.28 dB (Fig. 7).

On Monday, the lowest noise level was found to be 48.78 dB at 17:00, while the highest noise level was 57.92 dB at 14:00 and the average noise level was 52.36 dB in eye clinic. On Tuesday, the lowest noise level was found to be 49.68 dB at 14:00, while the highest noise level was 58.33 dB at 10:00 and the average noise level was 53.48 dB. On Wednesday, the lowest noise level was found to be 46.39 dB at 17:00, while the highest noise level was 58.91 dB at 10:00 and the average noise level was 52.08 dB. On Thursday, the lowest noise level was found to be 47.69 dB at 15:00, while the highest noise level was 59.16 dB at 09:00 and the average noise level was 52.70 dB. On Friday, the lowest noise level was found to be 46.95 dB at 16:00, while the highest noise level was 59.89 dB at 10:00. The average noise level in eye clinic was 52.96 dB (Fig. 8).



Fig. 8. The noise level at different days and hours in eye clinic.



Fig. 9. The noise level at different days and hours in emergency service corridor.

On Monday, the lowest noise level was found to be 46.26 dB at 17:00, while the highest noise level was 57.48 dB at 09:00 and the average noise level was 53.58 dB in eye clinic. On Tuesday, the lowest noise level was found to be 47.15 dB at 16:00, while the highest noise level was 60.09 dB at 10:00 and the average noise level was 53.16 dB. On Wednesday, the lowest noise level was found to be 47.38 dB at 17:00, while the highest noise level was 56.52 dB at 14:00 and the average noise level was 50.96 dB. On Thursday, the lowest noise level was found to be 47.58 dB at 14:00, while the highest noise level was 56.23 dB at 10:00 and the average noise level was 51.38 dB. On Friday, the lowest noise level was found to be 45.34 dB at 17:00, while the highest noise level was 55.75 dB at 11:00. The average noise level in emergency service corridor was 50.13 dB (Fig. 9).

As a result of the measurements made at Istanbul Okan University hospital, the highest noise level (59.02 dB) was determined at the main entrance of the hospital, while the lowest (51.80 dB) was in the emergency service corridor. The noise levels in the pediatrics department, emergency room entrance, audiology clinic, nuclear, medicine, cardiology clinic, and eye clinic are 57.39 dB, 56.31 dB, 55.10 dB, 54.63 dB, 53.36 dB, and 52.70 dB, respectively (Fig. 10).



Fig. 10. The noise level at different department in hospital.



Fig. 11. The noise level at different days in hospital.



Fig. 12. The noise level at different hours in hospital.

When the noise measurement results of all departments in the hospital are evaluated, the noise level is found to be highest on Tuesday. The average noise levels calculated for Monday, Tuesday, Wednesday, Thursday, and Friday are 55.49 dB, 56.16 dB, 54.73 db, 54.97 dB, and 54.09 dB, respectively (Fig. 11).

Based on the results of noise measurements at different working hours, it was found that they are at different levels. The highest noise level (57.91 dB) was found at 9 am. The minimum noise level (50.86 dB) was found at 5 pm (Fig. 12). Long-term exposure to noise pollution can cause many physical and psychological health problems. Some of the health problems associated with hearing are presbycusis and sensorineural hearing [13]. The likelihood of hearing loss is 85% for people who are exposed to a noise level of approximately 85 dB for 8 years per day for 40 years[14]. The non-auditory effects of noise pollution on human health are stress and sleep disturbance. Other effects of exposure to high levels of noise may include increased blood pressure, nausea, headache, and anxiety disorder [15].

Several studies have been conducted to determine the noise level in hospitals. In 2013, noise level measurements were made in 5 different hospitals in Istanbul, and the following results were obtained 70.28 dB, 71.57 dB, 74.42 dB, 70.42 dB, and 67.14 dB [16]. Study in 2013 conducted 3 different departments of a training and research hospital in Istanbul and the average noise levels were reported as 75 dB, 65 dB, and 65 dB [17]. In 2018, Yarar et al. measured noise levels at different departments in Istanbul Zeynep Kamil Hospital. The result of the study were noise level values between 65 dB and 74 dB [17]. In 2005, sound levels were measured at five different departments at Johns Hopkins Hospital in the USA. The noise level measurements performed in many units including the patient room, nurse stations and corridors were found to be 50–60 dB on average, and there were quite a few differences between the units [18]. In 2005, Tijunelis et al. investigated the noise levels in the emergency department. It was concluded that the xcessive noise level was in the emergency room [19]. In 2008, Akansel and Kaymakci investigated the effects of noise in intensive care units, and they found higher values of noise levels than those recommended [20]. In 2018, the daytime noise level in public hospitals was between 64.3 and 73.8 dB, while in private hospitals it ranged from 57.3 to 66.6 dB [21]. In case of studies in 3 different hospitals the noise level were found to vary between 54.3 and 62.6 dB [22].

In this paper, the noise level values were obtained for different departments in hospital, and they were estimated between 52 dB and 57 dB. Our result was similar to the noise level measurements by Philbin and Gray, but lower in comparison to other measurements conducted in hospitals. The noise levels in our study are lower than the level of 85–90 dB which may cause hearing impairment. However, it is higher than recommended noise levels (35 dB) in WHO guidelines.

### 4. Conclusion

The level of noise in hospitals affects health personnel and patients. Therefore, noise level has to be measured regularly. In this study, noise levels were measured in different parts of a university hospital in Istanbul. Measurements were made each day from Monday to Friday, from 8 am to 5 pm.

The results were compared with similar studies and recommendation by WHO guidelines. As a result of this study, average noise levels in different parts of the hospital were found between 52 dB and 57 dB. These noise levels were observed to be lower than in similar studies, but higher than the noise level recommended by the WHO. In fact, also in other studies the noise level was higher than the noise level recommended by WHO. Therefore, serious steps are needed to reduce hospital noise. In this way the productivity of healthcare professionals will increase, and patients will recover faster.

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