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Research Paper

Evaluation of sound pollution near several government and private hospitals in Najaf city

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ABSTRACT

Sound pollution is a notable aspect of the environment whose intensity varies with its source and which affects nearby buildings, including hospitals. Because most hospitals are located on major thoroughfares and near industrial and commercial activities, they are frequently exposed to high levels of environmental noise, although the care they provide requires rest and tranquillity for patients. This study determined the level of noise pollution caused by various activities around several government and private hospitals in Najaf city, Iraq. A sound level meter (IEC 61672-1 type 2) was used to measure noise levels near eight hospitals three times a day (morning, afternoon, and evening) on Sundays, Tuesdays, and Thursdays during June and July. The average noise levels measured outside the hospitals were considerably higher than the environmental noise limits of the World Health Organization and the Iraqi noise standards. Recommendations for lowering noise levels near hospitals are made.

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1. INTRODUCTION

Sound waves are mechanical stimuli characterized by their direction, speed, intensity (measured in decibels, dB), and frequency (in hertz) [1]. By human perception, sound is classified as infrasonic (< 20

Hz), audible (20 Hz–20 kHz), or ultrasonic (> 20 kHz). Sound also affects other organisms: plants can perceive sound through direct contact or vibration and through soil, water, or air [2], [3], and recent research has shown that sound stimulation can cause physiological changes in plant defence and disease responses, hormone signalling, gene expression, seed germination, growth, and flowering [4].

Environmental pollution has become a recognized global issue because of its serious long-term effects on human health. It can be defined as the addition of any material (solid, liquid, or gas) or energy (heat, sound, or radioactivity) to the environment at a rate greater than its capacity to disperse, dilute, decompose, recycle, or store it in a harmless form [5]. With rapid economic growth and dense urban populations, noise has a significant impact on the quality of life in cities [6], [7]. Permissible noise standards vary between countries according to land use (Table 1). Patients in hospitals need rest and quiet to recover from illness, so unacceptable noise from activities near government and private hospitals in Najaf can directly affect patients' health [8].

2. RELATED WORK

Noise pollution poses an insidious risk. It is any unwanted or disturbing sound that affects the health and well-being of people and other living creatures [2], [9]. Sound waves are vibrations of air molecules travelling from a source to the ear, described in terms of pitch (frequency) and loudness (amplitude); loudness is measured in decibels, a logarithmic scale of sound pressure level (SPL) [2]. Noise can cause mechanical damage to cells, tissues, and organs, affecting hearing and other tissues, and in addition to sound level, the frequency and duration of exposure matter, so sounds not perceived as very loud may still affect physical and emotional health [3]. Long-term noise exposure can cause annoyance, sleep disturbance, cardiovascular and metabolic effects, and cognitive impairment in children. In Europe, environmental noise is estimated to contribute each year to 12,000 premature deaths and 48,000 new cases of ischaemic heart disease, with 22 million people suffering chronic high annoyance, 6.5 million chronic high sleep disturbance, and 12,500 children impaired in reading ability by aircraft noise [10]. Hospitals are another setting where people are exposed to noise, from staff conversations to monitoring equipment, and noise has been identified as a primary source of disturbance for patients [11], [12] and as the most bothersome stressor in intensive care [12]; the resulting lack of restorative sleep ultimately affects patients' recovery [8].

Table 1. Permissible Noise Intensity Standards

Area Type	Permissible Limit During Day (dB)	Permissible Limit During Evening (dB)
Industrial areas and city centre	55–65	50–60
Residential areas near highways	50–60	45–50
Urban residential areas	45–55	40–50
Village residential areas, near hospitals, parks	35–45	30–40

3. MATERIALS AND METHODS

A descriptive survey was conducted, consisting of daily measurements of noise levels at selected locations near government and private hospitals in Najaf after determining their geographic coordinates. Noise levels were recorded in dB using a sound level meter (IEC 61672-1 type 2; Figure 1), and the results were compared with international and national noise standards to determine whether they fell within the permissible limits.



Figure 1. Sound Level Meter used in the Study

3.1 Study Area

Najaf is a large and important city in central Iraq, about 160 km south of Baghdad (32°01′44″ N, 44°20′23″ E), with a population of about 747,000. It is one of the holiest cities in Iraq, the burial place of Imam Ali, and the location of Wadi Al-Salam, the largest cemetery in the world, and it receives many visitors from Iraq and other countries throughout the year. The city has several well-known government and private hospitals, an airport, and many universities, schools, and kindergartens. Eight hospitals in different parts of the city were selected (Table 2).

Table 2. Hospitals Selected for the Study

Sample	Hospital	Location	Latitude (N)	Longitude (E)
A	Al-Sadeer Hospital	Kufa Street	32.018249	44.372310
B	Al-Frat Al-Awst Hospital	Al-Sahla Street	32.036055	44.384303
C	Al-Zahra Teaching Hospital	Al-Askan Street	31.999953	44.351816
D	German Hospital	Baghdadi Street	32.037876	44.333538
E	Aml Al-Hyat Hospital	Al-Kylydar Street	31.998645	44.344939
F	Al-Ghdyr Al-Ahly Hospital	Kufa Street	32.022394	44.386401
G	Al-Amyr Hospital	Al-Askan Street	32.001652	44.349558
H	Al-Mrkz Al-Iraqy Hospital	Al-Sahla Street	32.036303	44.385687

Noise was recorded near the eight hospitals over two months, on three days each week (Sunday, Tuesday, and Thursday) at three times of day, for 30 minutes at each location (Table 3).

Table 3. Measurement Times of the Study

Time	Measurement period	Reason
Morning	8:30–9:00 a.m.	Start of the working day
Afternoon	2:30–3:00 p.m.	End of school and office hours
Evening	8:30–9:00 p.m.	Rest time and less traffic

4. RESULTS

In the morning (8:30–9:00 a.m.), the highest noise level on Sunday was 89.8 dB at Aml Al-Hyat Hospital and the lowest 68.9 dB at Al-Mrkz Al-Iraqy Hospital. On Tuesday, Aml Al-Hyat Hospital again recorded the highest value (81.2 dB) and Al-Ghdyr Al-Ahly Hospital the lowest (70.5 dB). On Thursday, Aml Al-Hyat Hospital recorded the highest value (78.0 dB) and Al-Mrkz Al-Iraqy Hospital the lowest (70.1 dB) (Table 4).

Table 4. Noise Levels (dB) near the Hospitals in the Morning (8:30–9:00 a.m.)

Day	A	B	C	D	E	F	G	H
Sunday	77.4	85.1	79.2	74.5	89.8	74.5	86.4	68.9
Tuesday	78.5	75.5	76.1	74.3	81.2	70.5	75.4	74.2
Thursday	74.5	73.4	72.1	74.3	78.0	70.4	73.8	70.1

In the afternoon (2:30–3:00 p.m.), the highest noise level on Sunday was 90.2 dB at Al-Frat Al-Awst Hospital and the lowest 79.2 dB at the German Hospital. On Tuesday, the highest value was 83.2 dB at Al-Frat Al-Awst Hospital and the lowest 78.1 dB at Al-Ghdyr Al-Ahly Hospital. On Thursday, Al-Ghdyr Al-Ahly Hospital recorded the highest value (88.0 dB) and Al-Amyr Hospital the lowest (78.1 dB) (Table 5).

Table 5. Noise Levels (dB) near the Hospitals in the Afternoon (2:30–3:00 p.m.)

Day	A	B	C	D	E	F	G	H
Sunday	81.2	90.2	81.5	79.2	83.1	80.2	80.0	84.2
Tuesday	79.5	83.2	80.2	80.4	79.5	78.1	79.2	79.5
Thursday	78.5	79.2	79.4	79.8	78.8	88.0	78.1	79.5

In the evening (8:30–9:00 p.m.), the highest noise level on Sunday was 72.9 dB at Al-Zahra Teaching Hospital and the lowest 63.5 dB at Al-Mrkz Al-Iraqy Hospital. On Tuesday, Al-Frat Al-Awst Hospital recorded the highest value (70.5 dB) and Al-Mrkz Al-Iraqy Hospital the lowest (60.2 dB). On Thursday, Al-Frat Al-Awst Hospital recorded the highest value (72.5 dB) and Al-Ghdyr Al-Ahly Hospital the lowest (60.1 dB) (Table 6).

Table 6. Noise Levels (dB) near the Hospitals in the Evening (8:30–9:00 p.m.)

Day	A	B	C	D	E	F	G	H
Sunday	72.0	69.2	72.9	65.2	69.1	63.8	69.4	63.5
Tuesday	69.2	70.5	70.2	64.2	64.5	65.2	68.0	60.2
Thursday	65.8	72.5	68.5	62.4	71.2	60.1	70.3	61.1

4.1 Discussion

Noise levels near the selected hospitals exceeded the international and national permissible values for areas near hospitals (Table 1) by up to about 43 dB, because the hospitals are located on main streets that are crowded during the day. In the morning, noise levels near Al-Mrkz Al-Iraqy Hospital, located on a side street, were lower than those near the other hospitals but still exceeded the standards by about 33 dB, whereas the highest morning readings were recorded near Aml Al-Hyat Hospital, which is located close to a main street. Readings near Al-Sadeer Hospital were also high, comparable to those near most other hospitals. Najaf has narrow streets and many cars, which increase congestion and noise in the city, especially near hospitals. Noise levels did not differ much among the three selected days of the week because of the large number of people moving within Najaf on weekdays, although there was a slight difference between Sunday and Thursday, the beginning and end of the working week.

Noise was highest in the afternoon, exceeding the standards by about 40 dB, because the end of school and office hours causes heavy traffic near the hospitals, whereas at night noise levels decreased but

still exceeded the standards by about 25 dB. Overall, noise levels near hospitals in Najaf are high and unacceptable and may affect patients, and solutions to this problem are needed [13].

5. CONCLUSION

Noise levels near government and private hospitals in Najaf exceed the limits recommended by the World Health Organization and the national standards set by Iraqi Noise Control Law No. 41 of 2015, because the hospitals are located on main streets with heavy traffic. The lack of urban planning and overlapping land uses expose hospitals to high noise levels; the lack of roadside trees, which act as noise barriers, near hospitals, the use of electricity generators, and the reliance on taxis rather than buses further increase noise. The hospitals most exposed to noise pollution were Aml Al-Hyat Hospital and Al-Frat Al-Awst Hospital.

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Authors Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Mahmood Hameed Al-Safi	✓	✓	✓		✓	✓		✓	✓		✓		✓	
Lujain Ibrahim Hussain				✓	✓	✓		✓		✓				
Arjwan A. Alsudani	✓						✓			✓		✓		✓

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

Conflict of Interest Statement

No conflict of interest.

Informed Consent

Not Applicable.

Ethical Approval

Not Applicable.

Data Availability

This study draws on publicly available data. No new datasets were created.

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