

Noise Exposure in Urban Health Facilities: An Empirical Study from Khulna

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Abstract: Noise pollution is a significant environmental concern, particularly in urban areas where it poses serious risks to public health, well-being, and quality of life. This study assesses the extent of noise pollution in sensitive zones—specifically hospitals and clinics—within the Khulna City Corporation area of Bangladesh. The research aimed to examine spatial and temporal variations in noise levels, identify key noise sources, determine the variation of noise levels with time and evaluate their impacts. Primary data were collected through direct sound level measurements with a digital sound level meter, structured questionnaires, and focus group discussions across selected healthcare facilities. In several locations, average noise levels reached 80 dB, surpassing the recommended indoor limit of 45 dB. Peak noise periods were observed between 10:00–12:00 and 16:00–18:00, primarily due to heavy vehicular traffic and a high influx of visitors. Major sources of noise included road traffic, construction activities, and general crowd movement within hospital premises. Traffic noise was the most significant contributor, with noise levels reaching up to 90 dB near busy roads. The findings reveal that noise levels in and around hospitals frequently exceed the permissible limits set by the Government. Respondents reported adverse effects such as stress, difficulty in sleeping, and reduced concentration. These results highlight the urgent need for targeted noise mitigation strategies and stricter enforcement of environmental noise standards in healthcare settings to protect the well-being of healthcare professionals, patients, and the general public.

Keywords: Noise exposure, pollution, health facilities, noise levels, urban.

Introduction

Noise pollution is a growing concern in urban areas, impacting people's health and the environment. Sensitive places like residential areas, hospitals, schools, and parks are especially affected (WHO, 2018). Residents in these areas often face daily exposure to high noise levels, leading to health issues such as hearing loss, stress, and sleep

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disorders (Basner et al., 2014; Munzel et al., 2018). Environmental consequences such as disruptions to wildlife, reduced biodiversity, and deterioration in air and water quality have also been observed in areas impacted by chronic noise (Barber et al., 2010).

Khulna, Bangladesh, is no exception, with its many hospitals and clinics in densely populated areas experiencing significant noise pollution from sources such as traffic, industry, and human activities (Islam et al., 2020; Rahman & Ahmed, 2021). Excessive noise poses serious health risks, particularly for vulnerable groups like newborns, the elderly, and critically ill patients (WHO, 2018). Hospitals and clinics, where people seek medical care and recovery, should ideally provide a calm and quiet environment. Unfortunately, major healthcare centers in Khulna city have been grappling with persistent noise pollution that affects patients, staff, visitors, and the local community. High noise levels in healthcare facilities can lead to hearing loss, sleep disturbances, stress, cardiovascular problems, and a decline in the quality of care provided to patients (Busch-Vishniac et al., 2005; Darbyshire & Young, 2013).

Despite these risks, limited research has been conducted on noise pollution in healthcare settings in Bangladesh, highlighting a significant gap in the literature (Rahman & Ahmed, 2021). To address this issue, this study aimed to assess noise pollution levels in major hospitals and clinics of Khulna City Corporation, identify key sources of noise, analyze the severity of noise pollution, and explore its temporal variation over the course of the day. The findings offer valuable insights for healthcare administrators and policymakers to develop effective noise mitigation strategies and raise awareness about the importance of maintaining a quiet hospital environment to support better patient care.

Noise Pollution in Urban Context

Noise pollution has emerged as a significant public health concern, particularly in urban healthcare settings, where it can negatively impact patient recovery, staff performance, and overall care quality. In densely populated cities like Khulna, the issue is further intensified by high traffic and overcrowded healthcare facilities.

Several studies have been conducted on noise pollution in hospitals and healthcare facilities in various parts of the world. These studies have found that high noise levels can lead to adverse health effects, such as stress, sleep disturbances, and increased blood pressure (Basner et al., 2014; Hume et al., 2013). Hospitals' Noise pollution can also lead to communication difficulties, affecting patient care and outcomes (Berglund et al., 1996). In a study conducted in Pakistan, noise levels were found to exceed the

recommended levels set by the World Health Organization (WHO) in several areas of the hospital (Nafees et al., 2013). A study conducted in a hospital in Iran found that the main sources of noise pollution were hospital equipment, televisions, and visitors (Pouryaghoub et al., 2010). Similarly, a study conducted in a hospital in the United States found that the main sources of noise pollution were staff conversations and overhead paging (Ryherd et al., 2008).

External sources of noise pollution, such as traffic and construction noise, can also be significant contributors to noise levels in healthcare settings. A study by Rahman et al. (2021) found that traffic noise levels were significantly higher at hospitals located near busy roads compared to those in quieter areas. One study conducted in a tertiary care hospital in Dhaka found that noise levels exceeded the WHO limit in all the wards and that patients and staff reported high levels of annoyance due to noise (Khan et al., 2019).

Excessive noise in healthcare settings is a serious issue that can impact patient outcomes and staff well-being. To mitigate the impact of noise pollution, many countries and organizations have established policies and guidelines to regulate noise levels in healthcare facilities.

Bhattarai (2014) carried out a study to measure noise levels in different areas—silent, residential, and commercial—of Siddharthanagar Municipality using a sound level meter. The study found that noise levels in all locations were higher than the standard limits. The highest noise level was 81.9 dB at the bus park, while the lowest was 54.5 dB near the medical college. The study identified vehicle movement as the main source of noise pollution. In addition, poorly maintained roads and vehicles were found to contribute to the increased noise levels.

Singh et al. (2022) studied traffic noise levels in Kathmandu, Nepal. They observed vehicle flow directly and used secondary sources to collect time-series noise data. The study measured various noise indicators, including traffic noise level, noise pollution level, equivalent continuous sound level (L_{eq}), and minimum and maximum sound levels. Their findings showed that the L_{eq} values at all study locations were above 70 dB(A), exceeding national and international noise standards. This suggests a potential risk of negative health effects from noise pollution short. Among the different methods to reduce environmental noise, noise barriers were highlighted as effective. They also

noted that the shape of the barrier plays an important role in reducing noise, as supported by Astrauskas et al. (2021).

The World Health Organization (WHO) has provided guidelines for community noise levels, which are often used as a basis for noise regulation in healthcare settings. According to the WHO, the average noise levels in hospital patient rooms should not exceed 35 decibels during the day and 30 decibels at night (WHO, 2011). However, many healthcare facilities struggle to meet these standards, as noise levels from internal and external sources can exceed these limits.

In Bangladesh, the Environmental Conservation Act of 1995 provides the legal framework for regulating noise pollution in healthcare settings (Government of Bangladesh, 1995). The act sets noise standards for different areas, including residential, commercial, and industrial zones. However, there is a lack of specific guidelines for noise levels in healthcare facilities.

The existing research highlights the severity of noise pollution in healthcare settings and its potential impact on patients and healthcare professionals. The findings also suggest that various strategies can be employed to reduce noise pollution levels, including staff education, environmental modifications, and noise-reducing materials. Further research is needed to investigate the effectiveness of these strategies in reducing noise pollution levels in healthcare settings.

Materials and Methods

Location of the Study Area

The study area for this research is Khulna City Corporation, a major urban area located in the southwestern region of Bangladesh. Khulna covers about 59 square kilometers and is home to over 1.5 million people (Khulna City Corporation, 2021). It's a bustling commercial and industrial hub with large hospitals and clinics. Khulna's climate is humid subtropical, with a monsoon season from May to September (Banglapedia, n.d.). Summers are hot and humid, while winters are mild. Temperatures range from 25°C to 35°C, and the city gets around 2,000 mm of rain annually (Banglapedia, n.d.). Traffic congestion is a well-known issue in Khulna, contributing to noise pollution (Alam et al., 2017). Noise comes from construction and industrial activities (Islam et al., 2020). The city's healthcare system has expanded, but noise pollution in healthcare settings is a growing concern.

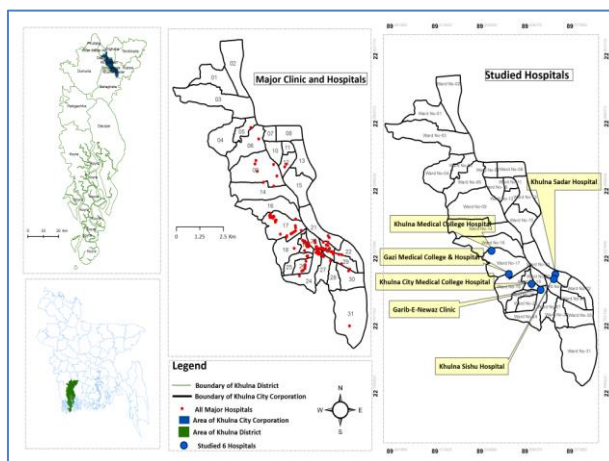


Figure 1: Map of KCC Showing the Major Clinics & Hospitals and Studied Area
Transportation system of the study area

Khulna is a major urban center with a well-established transportation network, primarily reliant on road transport. Predominantly reliant on road transport, the city hosts a mix of motorized (cars, buses, motorcycles) and non-motorized (rickshaws, bicycles) vehicles.

Table 1: Number of registered motor vehicles in KCC

Type of vehicle	Number of vehicles
Car	20,954
Microbus	6,028
Bus	1,330
Motorcycle	50,084

Source: Khulna City Corporation (2021)

According to the Bangladesh Road Transport Authority (BRTA) in 2021, Khulna had 79,079 registered vehicles, including 20,954 cars, 6,028 microbuses, 1,330 buses, and 50,084 motorcycles. These vehicles have led to increased traffic congestion and subsequent noise pollution.

As of June 2021, the Bangladesh Road Transport Authority (BRTA) reported 468,341 registered vehicles in Khulna district, showing an average annual growth rate of about

9.1% over the past five years. Among these vehicles, motorcycles accounted for 57%, light vehicles like cars and minibuses made up 34%, and heavy vehicles such as buses and trucks constituted the remaining 9%. Motorcycles and other two-wheeled vehicles are associated with higher noise levels due to their smaller engines and higher RPMs (Baliatsas et al., 2016). Additionally, horns and other signaling devices are common among drivers in Bangladesh, which can further increase noise levels in urban areas (Khan et al., 2014).

Table 2: Vehicle Stock in Khulna District (BRTA, 2021)

Vehicle Type	Number of Vehicles	Percentage (%)
Motorcycle	267,720	57%
Light Vehicle	157,464	34%
Heavy Vehicle	43,157	9%
Total	468,341	100%

Source: BRTA, 2021

Survey Procedure and Data Collection

The survey procedure for this study relied on both primary and secondary data collection. Primary data collection for this study involved using multiple methods, including instrumental surveys, questionnaires, focus group discussions (FGDs), and interviews. These approaches involved engaging patients, staff, attendants, and residents within the study area. The noise levels were measured in decibels (dBA) using the digital sound level meter across the six selected hospitals in Khulna City Corporation, conducted between December and January of 2023-2024, from 9 AM to 5 PM. The selected hospitals were Khulna City Medical College Hospital, Khulna Shishu Hospital, Garib Newaz Clinic Diagnostic Limited, Khulna Medical College Hospital, Gazi Medical College Hospital Pvt. Ltd., Khulna General Hospital. Measurements were taken indoors, outdoors, and at entrances, with the meter positioned at a 1.2-meter height. All the measurements were taken in normal atmospheric conditions. Raw data obtained from the field were organized and tabulated. Secondary data was collected from government agencies, hospitals, and other relevant sources.

Data Processing, Analysis and Interpretation

The collected information was carefully checked for completeness and accuracy. Any missing or unclear data was excluded. The survey data was first analyzed using numbers. Then, key ideas from group discussions were written down, and important

points from interviews were added to the analysis. This combined information was used to answer the research questions. The results were shown in tables, charts, and graphs for easier understanding. Microsoft Excel was used for the quantitative analysis of the data. Noise levels for different hospitals are presented in bar charts for clear visualization.

Result and Discussion

Noise pollution is a growing issue in urban areas, including Khulna City Corporation. Excessive noise can harm people's health, especially in places like hospitals where peace and silence are crucial for healing. This study has been considering three main goals. First, it aimed to measure noise pollution at healthcare centers in Khulna City Corporation, while an attempt has been made to understand its severity. To achieve the first goal, noise measurements were conducted at six health service centers using a digital sound level meter. Measurements were taken indoors, outdoors, and at entrances. The second goal was to see how noise levels changed throughout the day with time. To achieve the second goal, noise measurements were taken at different times of the day at the selected health service centers. The third goal is to identify and analysis of noise sources in the study area, which is a critical step in understanding the sources and characteristics of noise pollution. Table 3 presents maximum permissible noise levels in different areas of Bangladesh. These noise level limits are based on the Noise Pollution (Control) Rules of 2006.

Table 3: Maximum permissible noise levels in different areas of Bangladesh

Area	Time of Day	Maximum
	Daytime (6AM-9PM) Nighttime (9PM-6AM)	Permissible Noise Level (dB)
Sensitive Area such as park, school, hospitals and mosques	Daytime	50
	Nighttime	40
Residential	Daytime	55
	Nighttime	45
Mixed Area	Daytime	60
	Nighttime	50
Commercial	Daytime	70

Industrial	Nighttime	60
	Daytime	75
	Nighttime	70

Sources: Noise Pollution (Control) Rules of 2006

Noise Level at Different Areas of Healthcare Centers

In this study, the temporal variations in noise levels recorded between 9:00 AM and 5:00 PM across six selected hospitals. In this regard, the primary goal was to measure noise pollution levels in selected healthcare facilities in Khulna City and compare them to the permissible limits defined by the Noise Pollution (Control) Rules, 2006 of Bangladesh. According to these rules, hospitals are considered "silent zones" where noise should not exceed 50 decibels (dB) during the day (6 AM to 9 PM) and 40 dB at night. Figure 2 clearly shows how noise levels vary over time in different areas of each hospital, including the entrance, indoor spaces, and outdoor surroundings. It gives a detailed view of how noise levels change during different times of the day.

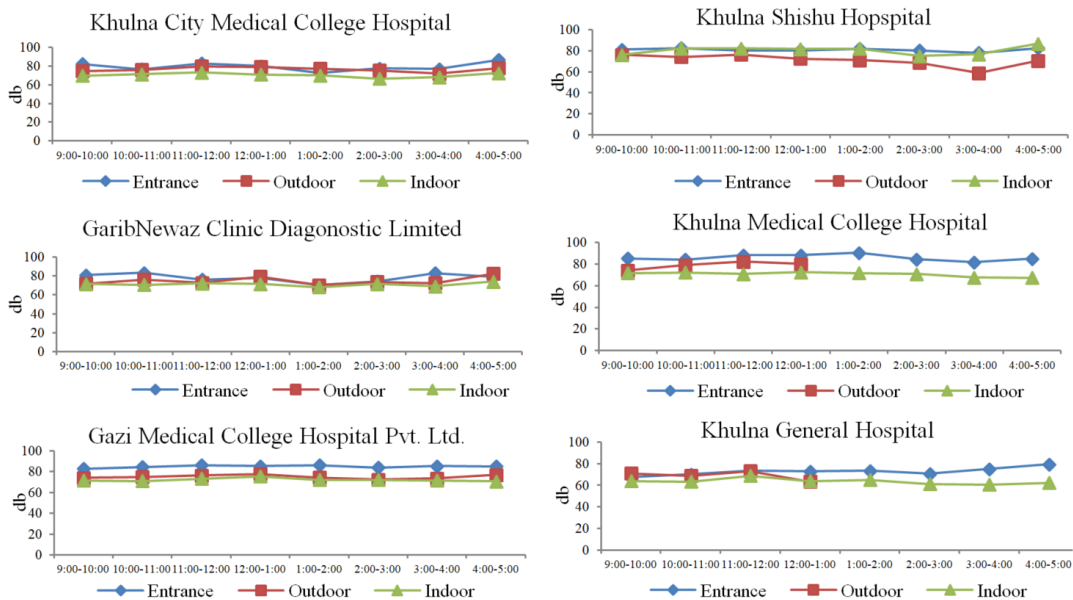


Figure 2: Temporal variations in noise levels recorded between 9:00 AM and 5:00 PM

Table 4: Variations in noise levels from 9:00 AM to 5:00 PM

Time	Location	Khulna City Medical College	Khulna Shishu Hospital	Garib Newaz Clinic & Diag Limited.	Khulna Medical College Hospital	Gazi Medical College Hospital Pvt. Ltd.	Khulna General Hospital
decibel (dB)							
9:00-10:00	Entrance	82.14	80.94	80.84	85.23	82.77	67.37
	Outdoor	74.84	75.97	71.84	74.23	73.96	70.71
	Indoor	69.87	75.99	71.85	71.63	71.14	63.88
10:00-11:00	Entrance	76.48	82.41	83.28	84.21	84.18	70.39
	Outdoor	76	73.97	76.25	79.03	74.81	68.71
	Indoor	71.49	82.12	70.75	72.16	70.76	63.22
11:00-12:00	Entrance	82.72	79.97	76.37	88.44	86.1	73.39
	Outdoor	79.73	76.34	72.74	82.37	76.16	73.03
	Indoor	73.08	82.04	72.27	71.03	73.25	68.76
12:00-1:00	Entrance	79.98	79.92	77.88	88.22	85.16	72.79
	Outdoor	79.33	72.42	79.28	80.08	77.65	62.99
	Indoor	71.01	81.45	71.84	72.43	75.34	63.95
1:00-2:00	Entrance	72.86	81.97	70.52	90.39	85.87	73.42
	Outdoor	77.24	71	70.23	-	74.36	-
	Indoor	70.2	81.77	68.28	71.71	72.05	65.11
2:00-3:00	Entrance	77.52	80.14	74.53	84.38	83.65	70.75
	Outdoor	75.05	68.62	73.74	-	72.23	-
	Indoor	66.62	74.9	71.47	71.04	71.77	61.14
3:00-4:00	Entrance	76.87	77.87	83.05	81.79	85.13	75.24
	Outdoor	71.85	58.75	72.57	-	73.4	-
	Indoor	68.24	76.68	69.33	67.77	71.5	60.77
4:00-5:00	Entrance	86.73	82.17	78.99	85.13	85.06	79.44
	Outdoor	77.88	70.45	82.57	-	76.71	-
	Indoor	72.58	86.45	74.09	67.36	70.5	62.19

Field survey, 2023-2024

Khulna City medical College Hospital

Khulna City Medical College Hospital is situated in the busy Moylapota area, a bustling commercial and residential hub of Khulna city. It's easily accessible by public transportation, with many buses, cars, and taxis serving visitors and patients. However, Khan Jahan Ali Road, where the hospital is located, often experiences heavy traffic, especially during rush hours, as it's used by various vehicles, including cars, buses, trucks, and motorcycles. Noise levels vary throughout the day, peaking between 11:00 AM and 12:00 PM, both indoors and outdoors, at 73.08 dB and 79.73 dB, respectively. This coincides with high human activity, loud conversations, and increased motor vehicle movement. A patient at Khulna City Medical College Hospital expressed concerns regarding the constant traffic noise outside the hospital premises. According to the patient, the noise from passing vehicles creates difficulty in resting and recovering, particularly during peak hours when the traffic volume is high. Additionally, the patient suggested implementing soundproofing measures in hospital wards or establishing designated quiet zones to mitigate the adverse effects of noise pollution on patients' well-being and recovery. The lowest indoor noise level occurs between 2:00 PM and 3:00 PM when public activity decreases, but it rises again due to the arrival of patients' relatives. At the entrance of Khulna City Medical College Hospital, the highest noise level reaches 86.73 dB between 4:00 PM and 5:00 PM, primarily due to heavy traffic noise, including cars and motorcycles passing by, as well as tire sounds and hydraulic horns. Throughout the day (from 9:00 AM to 5:00 PM), noise levels fluctuate between 72.86 dB and 86.73 dB, surpassing the government of Bangladesh's acceptable limit of 60 dB.

Khulna Shishu Hospital

Khulna Shishu Hospital, a well-known children's hospital, is centrally located in Khulna city. However, its prime location comes with constant traffic from buses, autos, rickshaws, and other vehicles passing by. This bustling road in front of the hospital can lead to noise pollution, which may affect the well-being of child patients. Additionally, the nearby Bhairab River, just 300 meters away, adds to the noise concerns as water vehicles traverse the river, contributing to the existing noise levels. Indoor noise levels vary throughout the day in Khulna Shishu Hospital. The highest, at 86.45 dB, occurs between 4:00 PM and 5:00 PM, coinciding with increased patient activities like medical procedures and visitors. The second-highest indoor noise level registers at 82.12 dB between 10:00 AM and 11:00 AM, primarily due to more patients' relatives, trolley movement, and loud conversations. The lowest indoor noise level is 74.9 dB during the

2:00 PM to 3:00 PM period. At the entrance of Khulna Shishu Hospital, the highest noise level is 82.41 dB between 10:00 AM and 11:00 AM. Noise levels remain consistent from 9:00 AM to 5:00 PM, with the highest levels observed during school and pick office hours. A mother at Khulna Shishu Hospital, talked about the noise around the hospital. She said it's hard to keep her child calm because of all the noise from traffic and other city activities nearby. She finds it especially tough to help her child sleep when it's noisy, especially during busy times. She thinks it would be helpful if they could make the hospital rooms quieter or set up quiet places for kids and families. This way, it would be easier for everyone to heal and feel better.

GaribNewaz Clinic Diagnostic Limited

GaribNewaz Clinic Diagnostic Limited is situated on Khan Jahan Ali Road in Khulna City, near Sat Rasta More. This area is typically busy with heavy traffic and a lot of people during peak hours. It's a bustling place with banks and businesses nearby, which adds to the noise. The constant flow of vehicles, like buses and trucks, creates significant noise that can affect the health of the hospital's patients, visitors, and staff. In the indoor situation, the highest noise level was 74.09 dB between 4:00 PM and 5:00 PM. The second-highest indoor noise level was 72.27 dB between 11:00 AM and 12:00 PM, mainly due to more patients' relatives, trolley movement, and loud conversations. Then it decreased to the lowest level, 68.28 dB, from 1:00 PM to 2:00 PM. It started rising again and reached about 71.47 dB from 2:00 PM to 3:00 PM. In outdoors, the highest noise level was 82.57 dB, mainly from 4:00 PM to 5:00 PM. At the entrance of GaribNewaz Clinic Diagnostic Ltd, there was noticeable noise, about 83.28 dB, between 10:00 AM and 11:00 AM due to heavy traffic. This clinic's location in Khulna city makes it a busy place with high public density and traffic load. A visitor at Garib Newaz Clinic Diagnostic Limited expressed concern about the noise pollution surrounding the clinic with activity due to its location near the busy Khan Jahan Ali Road. The constant stream of traffic, including buses, cars, and motorcycles, adds to the noise pollution in the area. The sounds of horns honking and engines revving create a cacophony that can be disruptive for patients seeking medical care. Additionally, the presence of nearby businesses and community gatherings contributes to the overall noise level. Despite the clinic's efforts to provide a healing environment, the surrounding noise poses a challenge for patients and staff alike, hindering the ability to concentrate and relax during medical visits. The visitor suggested exploring measures

such as scheduling quieter appointment times to mitigate the impact of noise pollution on patients' well-being."

Khulna Medical College Hospital

Khulna Medical College Hospital, situated in the Khalishpur area of Khulna, is a well-known medical facility. However, its location along a busy road brings a lot of noise pollution, which can be troublesome for patients, staff, and the local community. The constant traffic flow on the nearby Khulna-Dhaka highway, including buses and trucks, generates high noise levels. The hydraulic horns and vehicle engines add to this noise, causing discomfort to patients, visitors, and hospital staff. Since the hospital is always busy, the noise pollution is persistent, making it a challenging place, especially for those in need of rest. Indoors, the highest noise level was 72.43 dB between 12:00 PM and 1:00 PM. It then decreased to the lowest level, 67.36 dB, from 4:00 PM to 5:00 PM. Outdoors, the highest noise level reached 82.37 dB from 11:00 AM to 12:00 PM due to high public density and traffic. Notably, the entrance point of Khulna Medical College Hospital recorded a noise level of about 90.39 dB from 1:00 PM to 2:00 PM, mainly because of heavy traffic on the Khulna bypass road. This hospital's entrance had higher noise levels than both indoor and outdoor areas. An attendant in one of the ward at Khulna Medical College Hospital expressed concern about the noise levels during visiting hours. The attendant noted that the ward becomes particularly noisy when multiple visitors gather to see their loved ones, resulting in loud conversations and increased movement. This heightened activity contributes to a challenging environment for patients trying to rest and recover. The attendant suggested implementing measures such as limiting the number of visitors allowed per patient during visiting hours or designating specific areas for visitors to gather, thereby reducing noise levels in the wards and promoting a more conducive healing environment.

Gazi Medical College Hospital Pvt. Ltd.

Gazi Medical College Hospital Pvt. Ltd., situated along Mojib Sarani road in Sonadanga, Khulna, faces constant noise pollution due to its location near the busy Sonadanga bus station. The hospital is about 200 meters away from the station and is regularly exposed to noise from heavy traffic, especially buses and trucks. This problem worsens during peak traffic hours when hydraulic horns and vehicle engines add to the disturbance, making it challenging for patients and local residents to concentrate and relax. Indoors, the highest noise level was 75.34 dB between 12:00 PM

and 1:00 PM. It then decreased to the lowest level, 70.50 dB, from 4:00 PM to 5:00 PM. Outdoors, the highest noise level reached 77.65 dB from 12:00 PM to 1:00 PM due to public density, traffic, and the sound of television programs. Notably, at the entrance point of Khulna Surgical and Medical Hospital Pvt. Ltd., the noticeable noise level was approximately 86.1 dB, mainly due to heavy traffic load, as the clinic is located very close to the roadside. This proximity to the road results in high noise levels. A patient at Gazi Medical College Hospital Pvt. Ltd. expressed frustration about the disruptive noise originating from the nearby Sonadanga bus stand and the traffic along Mojid Sarani road. They highlighted the challenges of finding peace and rest within the hospital amidst the constant noise pollution. The patient suggested implementing measures to mitigate the impact of external noise, such as exploring the possibility of coordinating with local authorities to regulate traffic noise around the hospital area could help create a more tranquil environment conducive to patient recovery.

Khulna General Hospital

Khulna General Hospital, situated next to the Bhairab River, faces constant noise pollution due to its busy surroundings. The hospital is closely surrounded by multiple markets within 500 meters, adding to the congestion. Noise pollution is further exacerbated by water vehicles passing on the Bhairab River, affecting both daytime and nighttime peace. The continuous flow of traffic, including trucks, autos, and tempos, on the adjacent roads makes it a very noisy place. Hydraulic horns and vehicle engines contribute to high noise levels, causing discomfort to patients, visitors, hospital staff, and the local community. The noise levels fluctuate throughout the day. The highest indoor and outdoor noise levels, 68.76 dB and 73.03 dB respectively, were recorded between 11:00 AM and 12:00 PM. During this time, there's high movement of people, loud conversations, and motor vehicle activity. The lowest indoor noise level was observed between 3:00 PM and 4:00 PM due to reduced public movement, but it increased afterward as more patients' relatives arrived. A staff member at Khulna General Hospital voiced concerns about the significant noise pollution originating from the nearby Bhairab River, particularly from the horn blasts of vessels navigating the waterway. The incessant noise, compounded by the movement of lighter ship, trawler and other watercraft throughout both day and night, poses a considerable disturbance to patients and visitors alike. Also, during visiting hours, the hospital gets even louder with more people around. Outdoor measurements were only collected from 9:00 AM

to 1:00 PM as the outdoor area was closed at 1:00 PM. At the entrance point of Khulna General Hospital, a noticeable noise level of approximately 79.44 dB was recorded, primarily due to heavy traffic load, far exceeding the government of Bangladesh's acceptable noise limit of 50 dB.

From the above discussion it is clear that the noise measurements taken from six different hospitals between 9 AM and 5 PM were consistently and significantly above the daytime limit of 50 dB. The noise levels significantly exceed the Noise Pollution (Control) Rules of 2006, which allow a maximum of 60 dB in mixed areas and only 50 dB in silent zones like hospital premises. This indicates a serious noise pollution issue in and around these healthcare facilities.

Variation of Noise Level with Time

Excessive noise exposure can have adverse effects on human health and well-being, particularly in healthcare settings where a peaceful and quiet environment is critical for patients to heal. Therefore, it is essential to understand how noise levels vary with time to develop effective strategies to reduce noise pollution in these critical facilities. To achieve this objective, noise measurements were taken at different times of the day and night at the selected health service centers in the study area. The data collected was analyzed to determine the variation in noise levels throughout the day and night.

Noise Level Fluctuations across Different Time Intervals

Table 5 illustrates how noise levels change during the day. According to the survey, 46% of respondents said they found noise most disturbing between 5 PM and 7 PM. Another 40% reported noise as a problem from 10 AM to 12 PM. About 36% mentioned noise during the period from 12 AM to 3 PM, while 30% cited noise from 3 PM to 5 PM. The least complaints came from the periods of 8 AM to 10 AM and after 8 PM, with 20% and 18% of respondents, respectively.

Table 5: Variation of noise level and level of perceived indoor noise level with time

Variation of noise level with time		Level of perceived indoor noise level during the day and night time		
Time	Percentage	Noise Level	Day (%)	Night (%)
8 A.M-10 A.M	20%	Silent	10%	87%
10 A.M – 12 A.M	40%			
12 A.M – 3 P.M	36%	Moderate noisy	62%	13%
3 P.M- 5 P.M	30%	Noisy	25%	0%
5 P.M- 7 P.M	46%	Very noisy	3%	0%
After 8 P.M	18%			

Field survey, 2023-2024

Table 5 illustrates the level of perceived indoor noise level during the day and night time. Based on the responses from the four FGDs, the highest noise levels occur mainly between 10 AM to 12 PM and 4 PM to 6 PM due to heavy traffic and community noise. However, one group mentioned peak noise levels between 9 AM to 12 PM and 5 PM to 8 PM because of street vendors, loudspeakers, and vehicle horns. At night, most groups reported minimal noise, except for occasional disturbances like ambulance sirens, dog barking, or security guard whistles. One group noted increased noise from 6 PM to 8 PM due to a nearby market and more people moving around. In summary, daytime noise pollution, caused by traffic and human activity, remains a significant issue in these areas.

Major Sources of noise pollution

The identification of sources of noise pollution is crucial in developing effective strategies to reduce the harmful effects of noise on human health and well-being. The data for this study were obtained through questionnaire surveys and focus group discussions (FGDs) with the patients, nurses, staff, attendants and residents of the study area. The analysis of the data has provided valuable insights into the sources of noise pollution, their characteristics, and their impact on the residents' health and well-being.

Table 6 represents the different types of noise in the study area. In the questionnaire survey, participants were asked about the different types of noise they experienced. The majority of the participants (55%) reported experiencing noise from motor engines, while 67% reported noise from horns. A significant number of participants (45%) also reported noise from miking, while construction and industrial activities were reported by only 22% and 4% of the participants, respectively. A smaller percentage of participants reported noise from other sources (5%). Additionally, participants identified several other sources of noise, such as road hawking, trolley movement, generator, crying of children, traffic load, dog barking, excessive sound of television programs, public density, whistling of night guards, and official machineries.

Table 6: Different types of noise and the most disturbing types of noise have been experienced

Sources	Different types of noise have experienced participants (%)	Most 3 types of noise have experienced participants (%)
Motor Engine	55%	48%
Horn	67%	
Construction activity	22%	8%
Industrial activity	4%	11%
Miking	45%	45%
Over crowding		27%
Aircraft noise		1%
Community noise		14%
Others	5%	3%

Field survey, 2023-2024

Based on the findings from the four FGDs conducted, it was identified that there are several sources and causes of noise pollution in the selected areas. In the study, various focus groups were asked about the sources or causes of noise pollution in their locality. The responses discovered that the most common sources of noise pollution were related to human activities. These included sounds from motor engines, horns, and miking during community events or religious gatherings. Participants also reported noise pollution caused by construction activities, generators, and the sound of televisions and radios. It was also noted that whistling from night guards and the crying of children

were sources of noise pollution in some instances. Interestingly, some groups identified specific times of the day or night when noise pollution was most prevalent. For example, one group cited the noise from whistles of trains and launches at night, while another group mentioned the high level of noise during peak traffic hours. Overall, the study revealed that noise pollution in the locality was caused by a variety of factors, many of which were related to human activities.

Most Disturbing Types of Sound

Table 5 shows the top three types of disturbing sounds reported by the respondents. The survey results revealed that motor engine noise and loudspeakers (miking) were the most common sources of noise pollution, mentioned by 48% and 45% of respondents, respectively. Overcrowding was also a notable source, with 27% of respondents listing it among the top three. In contrast, aircraft noise and construction activity were the least mentioned, selected by only 1% and 8% of respondents. Industrial noise and community noise were chosen by 11% and 14% of respondents, showing they are moderately disturbing. Only 3% selected the "others" category, but some additional noise sources were still reported. These included road hawkers, brick crusher machines, generators, children crying, loud television, large crowds, and official machinery. These findings suggest that the survey options effectively covered most of the common noise sources experienced by the respondents.

Effects of Noise Pollution

The impacts of noise pollution on human being are now an alarming issue in medical science. Noise causes a lot of difficulties to human health. In this research it has been tried to find out the noise effects for the people of the study area and to analyze the present situation.

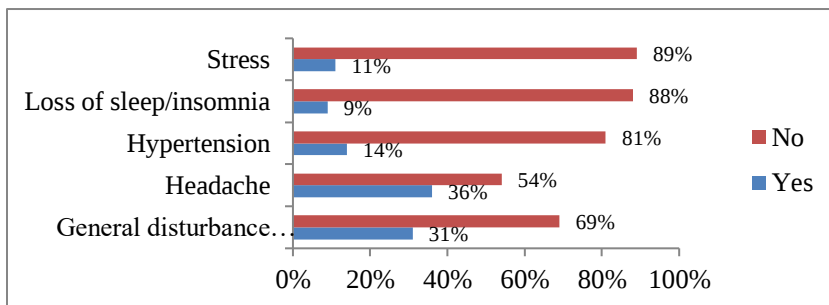


Figure 3: Prevalence of health effects caused by noise pollution

The results from both the questionnaire survey and focus group discussions (FGDs) shed light on the adverse health effects of noise pollution. Participants in the survey reported experiencing various issues, with 31% feeling general irritation, 36% suffering from headaches, and 14% dealing with hypertension due to noise pollution (figure 03). Additionally, 9% experienced sleep disturbances, and 11% reported increased stress levels. The FGDs echoed these findings, emphasizing that noise pollution has physical and psychological consequences. Some nearby shopkeepers near a hospital expressed concerns about the alarming levels of noise pollution, particularly during peak hours. They mentioned that the noise during peak hours was unbearable and interfered with their ability to communicate, often requiring them to raise their voices to be heard. Additionally, they noted their realization that prolonged exposure to such noise could lead to temporary hearing loss. Participants mentioned symptoms like dizziness, sleep disruptions, fatigue, headaches, and difficulties in concentration, mirroring the survey results. Some even faced more severe health problems like high blood pressure and hearing loss due to noise exposure. Furthermore, both the survey and FGDs highlighted the detrimental impact of noise pollution on children's health. Children experienced sleep disturbances, learning difficulties, attention problems, memory loss, and increased anxiety and stress. Learning problems, in particular, could hinder cognitive development and academic performance. In summary, these findings underscore the significant and wide-ranging negative effects of noise pollution on human health, including children, emphasizing the importance of addressing this environmental issue.

Regarding the impact of noise pollution on the environment, the FGDs revealed that excessive noise can harm birds and alter their habitat, leading to a decrease in their population. Animals also suffer from habitat changes and disturbances in their normal life. However, the exact nature and extent of the effects on the environment are not fully understood and require further investigation.

The impact of noise pollution on social relations and quality of living environment is a concern that also needs to be addressed. According to the survey, 14% of participants reported that noise pollution negatively impacts their social relations, while 20% felt that it impacts their quality of living environment. However, a large number of participants (71% and 68% respectively) felt that it did not apply to them. It is worrying that 55% of participants were not aware of the potential health impacts of noise pollution. This highlights the need for awareness campaigns to educate the public about the dangers of noise pollution on human health. Interestingly, the majority of

participants (63%) reported that they can tolerate noise pollution, suggesting that they have become accustomed to it. However, it is important to note that just because people can tolerate it; it does not mean that noise pollution does not have negative impacts on their health and well-being. Overall, these results suggest that while some people are aware of the impact of noise pollution on their social relations and living environment, there is a need for more education and awareness about its potential health impacts.

Approaches to Manage and Reduce Noise Pollution Exposure

According to the responses received from the participants, only 7% of them reported doing something to mitigate noise, while a vast majority of 93% did not take any action to reduce the noise around them. Similarly, only 18% of the respondents reported doing something to avoid noise, while 82% do not take any specific action to avoid noise. This indicates a lack of awareness among people about the harmful effects of noise pollution and the need for taking necessary measures to prevent it. When asked whether they have ever used earplugs or earmuffs to reduce noise, only 2% of the respondents reported using them, while 98% reported never using them. This further highlights the lack of awareness among people about the available solutions to reduce noise exposure.

Participants were asked to classify their working environment in terms of noise quality. The majority of respondents (52%) reported that their working environment was tolerable, while 25% classified it as quiet. A smaller percentage (14%) indicated that their working environment was noisy, and 9% described it as extremely noisy. These findings suggest that while a significant proportion of the participants reported moderate to high levels of noise in their working environments, a sizeable portion still perceived their environments as relatively quiet or tolerable and they have no control over minimizing the noise level.

Conclusion

Noise pollution is a growing problem in urban areas, affecting both physical and mental health and is often overlooked. This study has been carried out in Khulna City Corporation, highlighting the existing health service centers where noise levels exceeded the government-declared limits, particularly during peak hours. Traffic noise was a significant contributor. The study identified adverse effects on patients, including stress and sleep issues, and recommends awareness programs to address this issue. Overall, the study underscores the importance of tackling noise pollution in health service centers for the well-being of patients, staff, and the community, offering

insights for policymakers and facility management. Based on the findings of the study, the following short-term and long-term recommendations are suggested to mitigate the problem of noise pollution in the major health service centers in Khulna City Corporation area.

In the short term, several practical steps can be taken. One simple solution is to install soundproof curtains, carpets, and wall panels inside the buildings. These help lower noise and make the environment more peaceful for both patients and staff. Hospitals can also provide earplugs to patients and workers to protect them from loud sounds. Limiting the use of noisy machines, such as generators, especially during busy hours, can also help. Some machines can be redesigned to make less noise, or placed inside soundproof cabins. Adding vibration control systems and using quieter materials can also reduce noise. Outside the hospitals, traffic noise can be reduced by setting noise limits and banning horn use near clinics. Inside the buildings, noisy areas should be kept away from patient rooms if possible. Planting trees and shrubs around hospital areas can also help absorb sound. Staff should be trained about the health risks of noise pollution and how to prevent it.

In the long run, several important steps can be taken to reduce noise pollution in health service centers. One key solution is to use building designs that block outside noise. This includes using thicker walls and double-glazed windows, which help stop noise from entering the hospital. Another important strategy is to create and enforce rules or laws that limit noise from traffic and construction near hospitals. Hospitals should also regularly check noise levels inside their buildings and take action when noise becomes too high. Public awareness is also important. This can lead to long-term behavior change in the community. More research is needed to better understand where hospital noise comes from and how it affects patients' health. This information will help develop stronger, more effective solutions for the future.

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