Study of Noise Level in Roadside Surgery and Medicine Ward of a Hospital in Dhaka City

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Abstract. Rapid urban population growth in developing countries has significantly impacted environmental noise levels. In hospitals, located near busy roads, excessive background noise is a major concern for both patients and staff. Road traffic noise has significant negative effects on human health, particularly for hospital patients. Although many journal papers have been published previously, most of them have focused on themes related to intensive care units (ICUs). In particular, there are no published studies about the noise level in the roadside wards of hospitals. Therefore, this study aimed to assess the noise levels in the roadside wards of a naturally ventilated government hospital in Dhaka city. This study incorporates a combination of quantitative research methodologies. For this study, Dhaka Mahanagar General Hospital of Dhaka South City Corporation was selected. The hospital was located beside a busy road. Data was collected from four roadside wards. Noise levels measured in all the surveyed wards were greater than the WHO recommended value both at day and night. During the day, the mean noise level was 71.18 dBA and at night it was 75.19 dBA. At day time, noise levels vary from 82.5 to 54.5 dBA and at night from 81.4 to 70.4 dBA. Noise mapping found that road traffic noise was the primary source of the higher noise levels. Additional research should be undertaken in other roadside hospitals of the same type, utilizing similar methodologies to obtain a more complete understanding of the acoustic environment in roadside hospital wards across Bangladesh.

Keywords: Acoustic condition, Dhaka city Noise level, Roadside hospital ward.

1 Introduction

Population growth in urban areas of developing countries has garnered significant attention due to its extensive impact on environmental noise levels [1, 2]. As a consequence, the ambient noise level of roadside buildings is very high. Excessive background noise level is considered one of the top complaints by patients and staff in a roadside hospital. Hospitals have a lot of sound sources (such as air or railways, buildings with heavy machinery, construction activity, loudspeakers, and healthcare facilities, e.g., ambulances, delivery vans and refuse collection), but one of the most aggravating sounds is likely to be the noise from the roads [3].

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Road traffic noise has significant and wide-ranging effects on human health, impacting both physical and mental well-being [3-5]. Hospital patients are far more negatively impacted by noise because it hinders their ability to heal [6]. Noise disturbances can disrupt patients' rest, negatively impacting their health [7]. Noise has numerous negative effects on patients, including sleep disruption, which slows recovery and prolongs hospital stays [8, 9]. It increases stress and anxiety, impairing the healing process, while also causing the release of stress hormones like cortisol, which weakens the immune system and delays recovery [10]. Excessive noise can heighten pain perception, making patients more sensitive to discomfort, and contribute to cardiovascular problems such as elevated heart rates and high blood pressure, especially in vulnerable patients [11]. Additionally, noise can interfere with communication between patients and healthcare providers, leading to misunderstandings about treatment and care [12].

Noise in hospitals not only impacts patients but also negatively affects healthcare staff, reducing their well-being and performance [13, 14]. High noise levels lead to increased stress and fatigue, raising the risk of burnout and lowering job satisfaction [15]. Concentration and productivity suffer, as noise distracts workers from critical tasks, increasing the likelihood of errors and slowing down work efficiency [16]. Communication can be compromised with noise interfering in important exchanges, potentially endangering patient safety [17]. Prolonged exposure may result in hearing problems and increase the risk of accidents. Noise also contributes to emotional exhaustion, reducing job satisfaction and driving higher staff turnover [18].

Several organizations provide recommended noise limits for hospitals. WHO recommends that noise level in hospital wards during the day should not exceed 35 dBA. At night, the noise level should not exceed 30 dBA to ensure that patients can sleep without being disturbed [1]. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) recommend a maximum of 40 dBA in patient rooms and recovery areas and 45 dBA in corridors and operating rooms.

Numerous previous studies have highlighted that noise in hospitals is a significant problem. Busch-Vishniac et al. (2005) reviewed research on various medical facilities and hospitals across several nations from 1960 to 2005 and discovered that none of the studies complied with the 35 dBA recommendation by WHO [19]. Additionally, they discovered that since 1960, the average annual increase in sound levels in these wards has been 0.38 dBA during the day and 0.42 dBA at night. It was also noted that since 1960, the average noise level in hospitals has risen to 72 dBA during the day from 57 dBA and to 60 dBA during the night from 42 dBA. In research conducted at Bunda District Hospital in Tanzania's Lake Victoria Zone, noise levels in five wards were recorded every four hours for fifteen hours [20]. The noise level on the ward ranged from 45.7 to 62.2 dBA, with a mean of 57 dBA. The pediatric ward had the lowest noise level (35.9 dBA), whereas the male surgery ward had the highest (64.3 dBA). In a naturally ventilated teaching hospital in Dhaka, Bangladesh, two surgical and one medicine ward were subjected to an extensive noise survey. These wards had daytime noise levels between 48 and 63 dBA. According to analysis, the majority of the noise sources can be avoided entirely or in part [21].

Even though numerous journal articles were published in the past, the majority of them concentrated on topics like intensive care units (ICUs). General wards, where patients stay for treatment and recuperation for a few days to many weeks, received less attention. Especially no published research was found about the study of noise level in roadside ward of hospital. So, this research aimed to evaluate the existing noise levels in roadside ward of a naturally ventilated government community hospital in Dhaka city.

2 Methodology

This study employs a combination of quantitative research methodologies, particularly through experiment, computational, and analytic methods.

2.1 Selection of Hospital Building

As the main purpose of this study was to investigate the existing noise level of a roadside hospital ward, a roadside community hospital in Dhaka city was selected for the convenience of conducting the research in terms of accessibility and scale. The selected hospital was Dhaka Mahanagar General Hospital of Dhaka South City Corporation. This 150 bed hospital was located beside a busy road (Figure 1). This road is connected with Babubazar Bridge, which serves as an important connection between Dhaka and Keraniganj. Padma Bridge has most recently been connected to this road as well. The Babubazar Bridge is a key transit point, facilitating the movement of people and goods between the two regions.

A variety of vehicle types cross this bridge, including private vehicles (cars, motorcycles), public transportation (bus, minibus, and auto-rickshaw) and goods transportation (trucks, pickups and covered vans). This bridge experiences heavy traffic during its peak hour. Morning peak hour is 9:00–01:30, when commuters head to work and night peak hour is 20:00–0:00, with a surge of goods vehicles to avoid daytime traffic. So this strategic location makes the hospital both easily accessible to its users and noisy as a result of high traffic. Being the hospital building was just beside the road, the roadside wards of the hospital were polluted with high noise levels. The road was located on the south side of the hospital building.

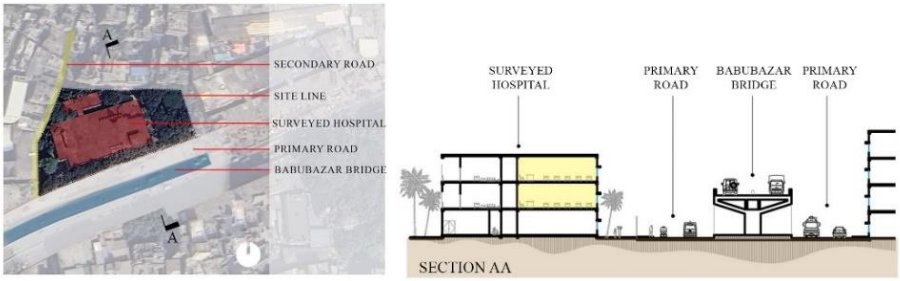

Fig. 1. (a) Site plan of surveyed hospital, (b) Section of hospital with adjacent road and bridge.

The hospital was a three-story structure with natural ventilation. Ground floor had no ward facility. The first floor consisted of three wards, two of which were located on the roadside. Also, there were two roadside wards on the second floor. 2 roadside wards located on the first floor were the male surgery ward and the female surgery ward. Another 2 roadside wards located on the second floor were the male medicine ward and the female medicine ward. The ward rooms included mosaic floors and hard plastered ceilings. Every ward room featured wooden doors. Each wardroom had a swing glass window. All surveyed wards were naturally ventilated through windows, while internal air flow was enhanced through ceiling fans. Data was collected in the male surgery ward and female surgery ward of the first floor, as well as the male medicine ward and female medicine ward of the second floor. Figure 2 shows the first and second floor plans of the hospital building.

Fig. 2. Plans of surveyed hospital building.

2.2 Data Collection

The study was conducted at 4 roadside wards with a bed occupancy rate of 70%. Measurements were taken at each ward for 18 hour period (6.00 to 0.00) with a sound level meter (TES-1353S). The TES-1353S is a compact, portable sound level meter that features a wide dynamic range (measuring range from 30 dBA to 130 dBA and frequency range from 31.5 Hz to 8000 Hz). At each ward, data was collected at 6 evenly distributed positions. The length of the ward was 12.19 m and the width was 10 m. For each space, the A-weighted noise levels were measured manually for every 2 hours from selected position of the room at a height of roughly 1.2 m from top of the floor surface, positioned 45º from the horizontal level [22, 23]. A-weighting is a common frequency weighting scheme that approximates noise level by de-emphasizing low-frequency sounds, which is comparable to the average human hearing response. A-weighted sound pressure levels are typically recorded as dBA. After recording data, the mean value of noise was calculated for each ward for 18 hours.

Figure 3 demonstrates schematic plans of wards showing 6 positions for measuring noise level.

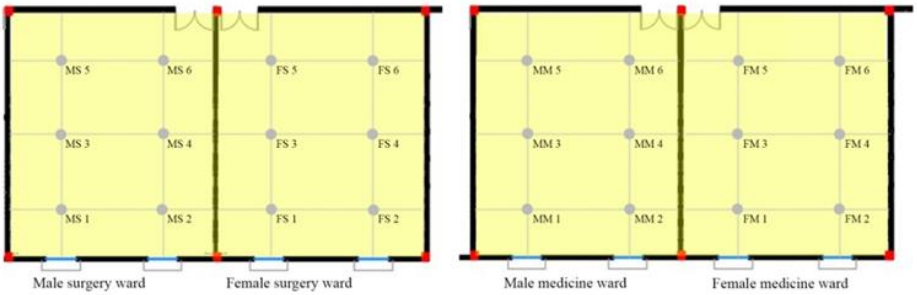

Fig. 3. Schematic plans of surveyed wards showing 6 positions for measuring noise level.

2.3 Data Analysis

The study attempted to analyze the existing noise level of the roadside ward, both during the day and at night. It did this by comparing the wards' current noise levels with WHO criteria.

This study also tried to check whether there was any statistically significant effect of noise level due to different time and different height. For this purpose, a one-way Analysis of Variance (ANOVA) is performed using the Analysis ToolPak extension of Microsoft Excel 2010 software. One-way ANOVA is a statistical test used to compare the means of three or more independent groups to determine if there are significant differences between them. The significance level (α) for the ANOVA test was chosen at 0.05 in accordance with earlier research on this topic [23-25]. In the ANOVA test, the F0 value is a ratio of two independent measures of variance for the provided data. The Fcrit value is a specific value to which the resulting F0 value is compared. If the F0 value in the ANOVA test is greater than the Fcrit value, the null hypothesis is rejected and the alternative hypothesis is accepted. If F0 value is less than the Fcrit value, it indicates that there is insufficient evidence to reject the null hypothesis.

3 Results and Discussion

3.1 Noise Levels in Wards

The mean noise level found in every ward from 6:00 to 0:00 is illustrated in Figure 4. The graphs show that noise level was high in every ward. In all wards, the noise level was greater than 55 dBA. The noise level was lowest at 6:00 and highest at 12:00. Maximum noise level at 12:00 was 78.3 dBA and minimum noise level at 6:00 was 57.0 dBA. Noise level appeared to increase steadily from 8:00, reaching its peak at

approximately 12:00. After 12:00, the noise level began to decrease, continuing to decline until 16:00. After 16:00, the noise level began to increase again.

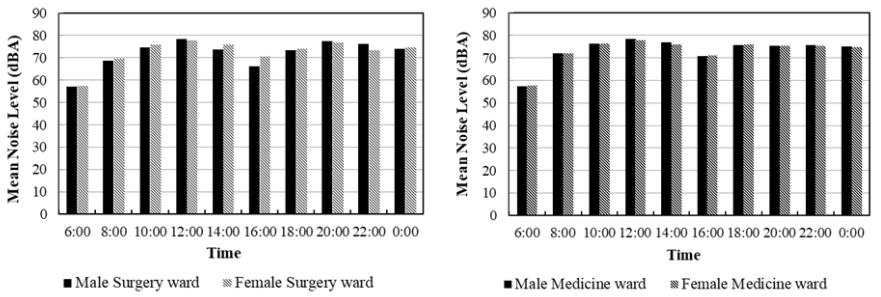

Fig. 4. Mean noise level in dBA of surveyed wards.

The mean, standard deviation (SD), maximum and minimum values of the noise level (dBA) of the male surgery ward and the female surgery ward are presented in Table 1. At day time, in the male surgery ward, the mean noise level was 69.7 dBA and in the female surgery ward, it was 71.2 dBA. Both in this ward, noise levels vary from 81.3 dBA to 54.5 dBA at day time. At night time, in male the surgery ward mean noise level was 75.2 dBA and in the female surgery ward was 74.7 dBA. Both in this ward, noise levels vary from 81.4 dBA to 70.4 dBA at night time.

In Table 2, the mean, standard deviation (SD), maximum and minimum values of the noise level (dBA) of the male medicine ward and the female medicine ward are illustrated. At day time, in the male medicine ward, the mean noise level was 71.9 dBA and in the female surgery ward, it was 71.8 dBA. Both in this ward, noise levels vary from 82.5 dBA to 55.2 dBA at day time. At night time, in the male medicine ward mean noise level was 75.5 dBA and in the female surgery ward was 75.3 dBA. Both in this ward, noise levels vary from 78.9 dBA to 71.2 dBA at night time.

Table 1. Mean, Standard Deviation (SD), Maximum and Minimum value of noise level in dBA of surveyed wards located in first floor.

		Male Surgery ward				Female Surgery ward			
	Time	Mean	SD	Max	Min	Mean	SD	Max	Min
Day time	6:00	57.0	1.6	59.2	54.5	57.4	1.7	59.6	55.1
	8:00	68.6	2.7	72.6	65.4	69.5	1.4	71.5	67.8
	10:00	74.6	1.7	76.8	72.4	75.9	1.2	77.7	74.7
	12:00	78.3	2.2	81.3	75.5	78.0	1.4	79.8	76.2
	14:00	73.7	1.7	75.9	71.4	76.0	1.8	78.6	74.5
	16:00	66.3	1.4	67.8	64.3	70.7	0.4	71.5	70.3
		69.7	**6.9**	**81.3**	**54.5**	**71.2**	**6.9**	**79.8**	**55.1**
Night time	18:00	73.2	2.3	76.4	70.4	74.1	1.4	75.9	72.3
	20:00	77.5	2.5	81.4	74.6	76.9	1.3	78.7	75.2
	22:00	76.1	2.2	78.9	73.1	73.4	1.0	74.6	72.3

	0:00	74.0	1.8	75.9	71.7	74.5	0.8	75.7	73.6
		75.2	**1.7**	**81.4**	**70.4**	**74.7**	**1.3**	**78.7**	**72.3**

Table 2. Mean, Standard Deviation (SD), Maximum and Minimum value of noise level in dBA of surveyed wards located in second floor.

		Male Medicine ward				Female Medicine ward			
	Time	Mean	SD	Max	Min	Mean	SD	Max	Min
	6:00	57.4	1.5	59.7	55.3	57.7	1.9	60.3	55.2
	8:00	72.1	1.6	73.8	69.5	71.9	1.8	73.8	69.1
Day	10:00	76.4	2.0	78.4	73.4	76.4	2.4	79.5	73.0
time	12:00	78.3	2.2	82.5	75.6	77.8	2.2	82.2	75.2
	14:00	76.8	2.2	79.8	73.2	76.0	1.9	77.9	72.8
	16:00	70.7	1.0	72.5	69.3	71.1	1.1	72.5	69.4
		71.9	**7.0**	**82.5**	**55.3**	**71.8**	**6.8**	**82.2**	**55.2**
	18:00	75.8	1.4	77.6	73.5	76.0	1.9	78.9	73.1
Night	20:00	75.4	1.5	78.3	73.7	75.4	1.7	78.5	73.3
time	22:00	75.8	2.1	78.9	72.6	75.3	2.1	78.6	72.2
	0:00	75.2	2.1	78.5	71.6	74.6	1.8	76.6	71.2
		75.5	**0.3**	**78.9**	**71.6**	**75.3**	**0.5**	**78.9**	**71.2**

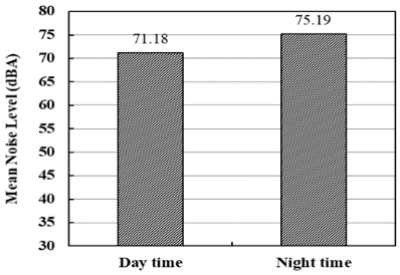

Fig. 5. Mean noise level at day and night time of surveyed wards.

Previous discussion shows that mean noise level in day time and night time differs significantly in all wards. Daytime denotes the period from 6:00 to 17:00, while night time denotes the period from 17:00 to 6:00. Figure 5 illustrates the mean noise level of all surveyed wards according to time. During the day, the mean noise level was 71.18 dBA and at night it was 75.19 dBA. At both times, the mean noise level was greater than the WHO recommended value. WHO recommends that noise level during the day should not exceed 35 dBA. At night should not exceed 30 dBA.

Time	Male Surgery Ward	Female Surgery Ward	Male Medicine Ward	Female Medicine Ward
6:00				

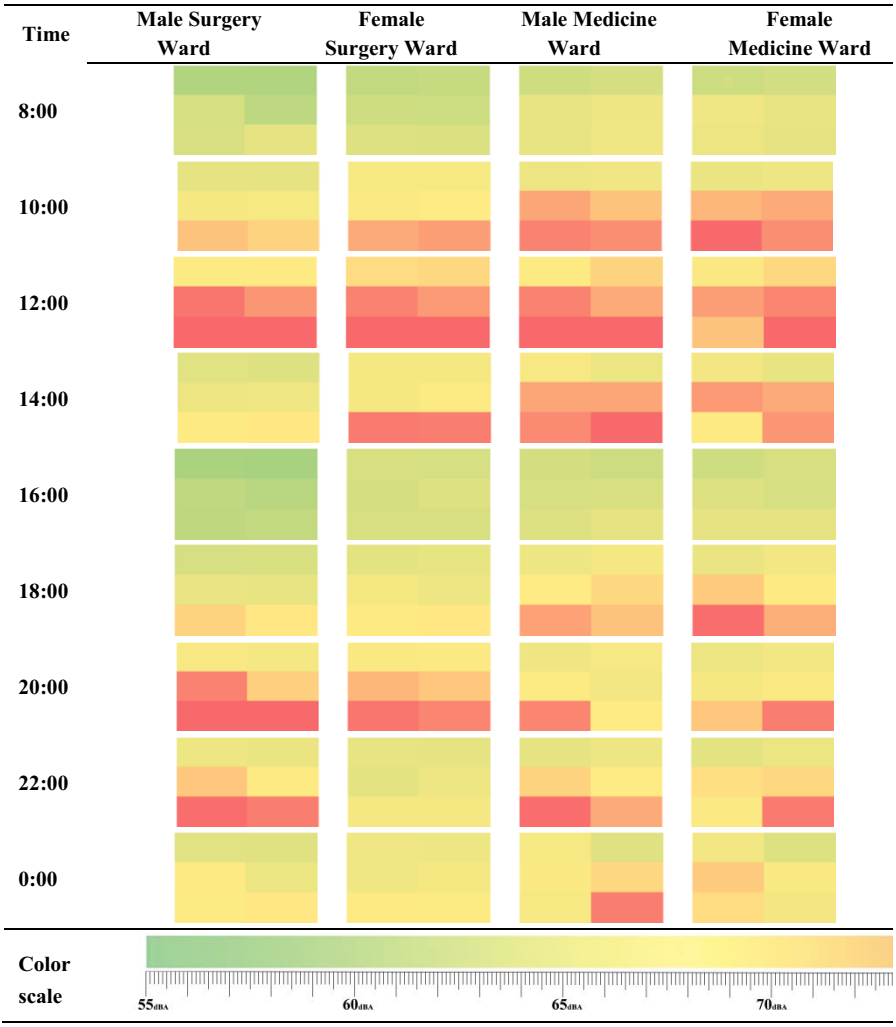

Fig. 6. Colour mapping of noise at 6 positions of four surveyed wards.

Figure 6 shows colour mapping of the noise level of 6 positions, as mentioned in Figure 2, of four surveyed wards from 6:00 to 0:00. Maps demonstrate the fact that noise levels in wards vary due to different times. Noise was relatively lower at 6:00 and 16:00 and relatively higher at 12:00 and 20:00. The maps clearly indicate that the elevated noise levels were primarily due to the presence of road traffic noise. Because almost all the wards had higher noise levels at road side positions.

3.2 Road Side Traffic Noise Sources

The road in front of the surveyed hospital was a major thoroughfare with high traffic volume. The traffic noise that contributed to the elevated noise levels within the hos-

pital wards originated from various sources. For example, noise of vehicle engines, particularly from trucks, buses, and motorcycles; noise from the vehicle horn; noise produced during sudden or heavy braking; noise from the vehicle exhaust system, especially in vehicles with modified or damaged exhausts; heavy vehicle noise which was intense and had a higher decibel level; continuous noise from cars that are stopped or going slowly.

3.3 Statistical Analysis

It was initiated to check whether there was any statistically significant effect of noise level due to different time and different height. The results of the ANOVA for mean noise level due to different times in the surveyed wards are summarized in Table 3. Here the F0 value is greater than the F_{crit} value, so it can be stated that there is statistically significant effect of mean noise level due to different times. The results of the ANOVA for mean noise level due to different heights in surveyed wards are summarized in Table 4. Here the F_{crit} value is greater than the F0 value, so it can be stated that there are no statistically significant effect of mean noise level due to different heights.

Table 3. ANOVA for mean noise level in surveyed wards due to different time.

Source of Variation	SS	df	MS	F0	P-value	F crit
Between Groups	1300.47	19	68.44	37.23	1.27x10-11	2.14
Within Groups	36.76	20	1.838			
Total	1337.23	39				

Table 4. ANOVA for mean noise level in surveyed wards due to different height.

Source of Variation	SS	df	MS	F_0	P-value	F_{crit}
Between Groups	10.43	1	10.43	0.2989	0.587	4.098
Within Groups	1326.79	38	34.91			
Total	1337.23	39				

4 Conclusion

The noise level measured in the roadside male surgery ward, female surgery wards, male medicine ward and female medicine ward were greater than the WHO recommended value both day time and night time. The level of noise seemed to rise gradually, starting at 8:00 and peaked at about 12:00. The noise level started to drop after 12:00 and kept going down till 16:00. The noise level started to rise again after 16:00. At day, the mean noise level was 71.18 dBA and at night it was 75.19 dBA. The elevated noise levels observed during night time were attributed to the presence of heavy vehicles operating on the adjacent road. At night noise level increased after 20:00 because of the movement of heavy vehicles, such as trucks and cargo transport, on the adjacent road. At day time, noise levels vary from 82.5 to 54.5 dBA and at night from 81.4 to 70.4 dBA.

Noise mapping revealed that the presence of road traffic noise was the main cause of the higher noise levels, because the noise intensity at roadside locations was higher in practically every ward. The common sources of road traffic noise were noise from the vehicle engine, vehicle horn, heavy braking, and vehicle exhaust system.

Moreover, ANOVA test results show that different times had a statistically significant effect on the mean noise level. However, there was no statistically significant effect on mean noise level due to height. The mean noise level was influenced by different times of day and night; however, there was no significant variation in noise levels between wards located on the first and second floors.

Due to time constraints the study was limited to a single hospital in Dhaka. Further research should be carried out in additional roadside hospitals of similar type employing comparable methodologies to gain a more comprehensive understanding of the overall acoustic environment in roadside hospital wards across Bangladesh.

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