

## An Annoyance and Sleep Disturbance Related to Environmental Noise Exposure Outside in Dhaka Airport Area

Dr. Abul Bashar<sup>1\*</sup>, Dr. Nusrat Khan<sup>2</sup>, Dr. Abul Eshrat<sup>3</sup>, Dr. ASM Shahidullah<sup>4</sup><sup>1</sup>Assistant Professor, Department of Community Medicine–SSNIMC, Kishoregonj, Bangladesh<sup>2</sup>Medical Officer, Diabetic Hospital, Kisorgonj, Bangladesh<sup>3</sup>Senior Anesthesiologist, Dhaka Medical College Hospital, Dhaka, Bangladesh<sup>4</sup>Associate Professor, Department of Community Medicine, President Abdul Hamid Medical College, Kishoregonj, BangladeshDOI: [10.36347/sjams.2020.v08i03.016](https://doi.org/10.36347/sjams.2020.v08i03.016)

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\*Corresponding author: Dr. Abul Bashar

## Abstract

## Original Research Article

**Background:** Noise has been shown to fragment sleep, reduce sleep continuity, and reduce total sleep time. Sleep is a biological imperative and a very active process that serves several vital functions. Undisturbed sleep of sufficient length is essential for daytime alertness and performance, quality of life, and health. **Methodology:** A cross sectional study is to estimate the degree annoyance and sleep disturbance related to sound occupational noise exposure in Dhaka Airport Area at 100 people. The municipality is characterized by homogeneous social structure and living conditions of the residents. For noise measurements, a Noise Level Analyzer was used. Three measurements were performed at daytime (between 9 and 10:30 am, 2 and 3:30 pm, and 6 and 7:30 pm) and two at night (between midnight and 1:30 am, and 3:30 and 5:00 am). Equivalent noise levels ( $L_{Aeq}$ ) were automatically calculated as continuous steady noise levels that would have the same total A-weighted acoustic energy like the real fluctuating noise measured over the same period. **Results:** Majority 35(35.0%) patients had sound level 55-60 dB ( $L_{Aeq,24\text{ hour}}$ ) followed by 21(21.0%) 60-65 dB ( $L_{Aeq,24\text{ hour}}$ ), 19(19.0%) <55 dB ( $L_{Aeq,24\text{ hour}}$ ), 17(17.0%) 65-70 dB ( $L_{Aeq,24\text{ hour}}$ ) and 8(8.0%) had >70 dB ( $L_{Aeq,24\text{ hour}}$ ). Regarding cardiovascular effect, 15(15.0%) had myocardial infarction, 13(13.0%) hypertension, 9(9.0%) ischaemic heart disease, 5(5.0%) stroke. Regarding psychological effects 12(12.0%) had depression, 7(7.0%) anxiety, 3(3.0%) fatigue, 2(2.0%) primary insomnia and 2(2.0%) impaired concentration. Regarding other effects, 7(7.0%) had headache, 4(4.0%) visual or hearing impairment, 3(3.0%) obstructive sleep apnoea, 2(2.0%) effect on birth weight. **Conclusion:** The study evaluated the level of annoyance and sleep disturbance that is perceived by the residents of Niketon Housing Project. It was also provide information about the various sources of environmental noise perceived by the dwellers. It is to estimate any association between noise exposure and annoyance or sleep disturbance. **Keywords:** Annoyance Sleep Disturbance Environmental Exposure.

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## INTRODUCTION

Sleep is a biological imperative and a very active process that serves several vital functions. Undisturbed sleep of sufficient length is essential for daytime alertness and performance, quality of life, and health [1]. Noise has been shown to fragment sleep, reduce sleep continuity, and reduce total sleep time [2]. One of the major environmental problems of the modern world is noise. A health-related marker of environmental noise exposure that can be considered a predictor of annoyance is noise sensitivity [3]. Noise pollution, along with air and water pollution, represents one of the major forms of environmental pollution around the world and is considered a public health problem WHO, 2011[4]. Although noise is regarded as undesirable, it is a pollutant whose effects on health are

often disregarded because people become accustomed to it [5]. Air, road, and railway traffic, the three major sources of traffic noise, have been reported to differently impact on annoyance. However, these findings may not be transferable to physiological reactions during sleep which are considered to decrease nighttime recovery and might mediate long-term negative health effects. Studies on awakenings from sleep indicate that railway noise, while having the least impact on annoyance, may have the most disturbing properties on sleep compared to aircraft noise [5]. Sleep is an important modulator of hormonal release, glucose regulation and cardiovascular function. In particular slow-wave sleep, the most restorative sleep stage, is associated with decreased heart rate, blood pressure, sympathetic nervous activity and cerebral glucose utilization, compared with wakefulness. During this

sleep stage, growth hormone is released while stress hormone cortisol is inhibited [6, 7]. Healthy sleep plays also an important role in memory consolidation [8]. As a result of sleep disturbances, children also suffer from impaired cognition and worsening of attention deficit hyper- activity disorder symptoms.

## METHOD

A cross sectional study is to estimate the degree annoyance and sleep disturbance related to sound occupational noise exposure in Dhaka Airport Area at 100 people. The municipality is characterized by homogeneous social structure and living conditions of the residents. For noise measurements, a Noise Level Analyzer was used. Three measurements were performed at daytime (between 9 and 10:30 am, 2 and 3:30 pm, and 6 and 7:30 pm) and two at night (between midnight and 1:30 am, and 3:30 and 5:00 am). Equivalent noise levels ( $L_{eq}$ ) were automatically calculated as continuous steady noise levels that would have the same total A-weighted acoustic energy like the real fluctuating noise measured over the same period. This approach to noise measurement has been adopted by the International Standard Organization for the measurement of community noise (ISO 1982). Other two noise parameters,  $L_1$  and  $L_{99}$ , were instrumentally calculated as noise levels that had been exceeded for 1% and 99% during the measurement period, respectively. Each measurement lasted 15 minutes and sampling speed was 10 samples per second. The obtained values of noise levels were free-field, with facade reflex included. Light and heavy vehicles were counted per hour at each measurement site. The measurements were performed at two sites in each of the six streets. Overall, there were a total of 10 measurements per street. Three streets with the highest and three streets with the lowest  $L_{eq}$  values were chosen to represent noisy and quiet areas, respectively. According to the criteria of Organization for Economic Cooperation and Development, noisy area belonged to "black acoustic zone" (above 65 dB(A)  $L_{eq}$ ), whereas quiet area belonged to "white acoustic zone" (below 55 dB(A)  $L_{eq}$ ). The questionnaires were distributed to all apartment residents in the area through their mail boxes. The number of distributed questionnaires corresponded with the number of dwellers in each apartment. Adults were asked to fill out the questionnaires by the next day, when these were collected. To be enrolled in the study, the residents had to live at the present address for longer than 10 years and have their bedroom windows facing the street. Long-term exposure to noise is considered to be of public health importance for sleep disturbances as one might expect the noise sensitive minority to move away from noisy area in the first few years of dwelling. The exclusion criteria were the presence of chronic diseases that might cause sleep disturbances and hearing loss. Out of 403 questionnaires distributed, 339 were filled out, giving the response rate of 77%. Twenty-nine subjects were excluded because they did not meet the

inclusion criteria. The final sample consisted of 100 respondents.

## RESULTS

Out of 100 respondents, majority 42(42.0%) populations belonged to age 31-40 years with mean age  $37.5 \pm 11.7$  years. Male were predominant (57.0%). Most of the populations were married (87.0%) and 37(37.0%) populations completed graduate and above education level. Most of the populations were housewife (40.0%) and rest 33(33.0%) were service holder (Table I). Aircraft noise was found 28(28.0%), road traffic noise 57(57.0%) and railway noise 15(15.0%) (Table II). 17(17.0%) population's exposure to noise during the day and 83(83.0%) exposure during the night (Table III). Mean duration of night sleep was  $6.7 \pm 1.3$  hours, mean difficulty with falling asleep was  $2.3 \pm 0.6$ , mean time needed to fall asleep was  $1.7 \pm 0.9$ , mean sleep quality was  $3.5 \pm 0.7$ , mean use of sleeping pill was  $1.4 \pm 0.6$ . Sleeping by open window 49(49.0%), waking up at night 62(62.0%) and difficulty in falling back to sleep 34(34.0%) (Table IV). Knowledge about noise exposure was 34(34.0%) (Table V). Majority 35(35.0%) patients had sound level 55-60 dB ( $L_{Aeq,24 \text{ hour}}$ ) followed by 21(21.0%) 60-65 dB ( $L_{Aeq,24 \text{ hour}}$ ), 19(19.0%) <55 dB ( $L_{Aeq,24 \text{ hour}}$ ), 17(17.0%) 65-70 dB ( $L_{Aeq,24 \text{ hour}}$ ) and 8(8.0%) had >70 dB ( $L_{Aeq,24 \text{ hour}}$ ) (Table VII). Regarding cardiovascular effect, 15(15.0%) had myocardial infarction, 13(13.0%) hypertension, 9(9.0%) ischaemic heart disease, 5(5.0%) stroke. Regarding psychological effects 12(12.0%) had depression, 7(7.0%) anxiety, 3(3.0%) fatigue, 2(2.0%) primary insomnia and 2(2.0%) impaired concentration. Regarding other effects, 7(7.0%) had headache, 4(4.0%) visual or hearing impairment, 3(3.0%) obstructive sleep apnoea, 2(2.0%) effect on birth weight (Table VIII).

**Table-I: Socio-demographic factors of the study populations (n=100)**

Socio-demographic factors	Frequency	Percentage
<b>Age (years)</b>		
20-30	27	27.0
31-40	42	42.0
41-50	31	31.0
Mean $\pm$ SD	37.5 $\pm$ 11.7	
<b>Gender</b>		
Male	57	57.0
Female	43	43.0
<b>Marital status</b>		
Married	87	87.0
Unmarried	13	13.0
<b>Education status</b>		
Illiterate	4	4.0
Primary	7	7.0
SSC	21	21.0
HSC	31	31.0
Graduate and above	37	37.0
<b>Occupation status</b>		
Housewife	40	40.0
Businessman	18	18.0
Service holder	33	33.0
Others	9	9.0

**Table-II: Source of noise exposure of the study populations (n=100)**

Source of noise exposure	Frequency	Percentage
Aircraft noise	28	28.0
Road traffic noise	57	57.0
Railway noise	15	15.0

**Table-III: Level and location of exposure to noise of the study populations (n=100)**

Level and location of exposure to noise	Frequency	Percentage
During the day	17	17.0
During the night	83	83.0

**Table-IV: Parameters of sleep disturbance of the population (n=100)**

Sleep disturbance parameters	Mean±SD
Duration of night sleep (h)	6.7±1.3
Difficulty with falling asleep (grade)	2.3±0.6
Time needed to fall asleep (grade)	1.7±0.9
Sleep quality (grade)	3.5±0.7
Tiredness after sleep (grade)	2.8±0.9
Use of sleeping pills (grade)	1.4±0.6
	<b>n (%)</b>
Sleeping by open window	49(49.0)
Waking up at night	62(62.0)
Difficulty in falling back to sleep	34(34.0)

**Table-VI: Knowledge about noise exposure of the study populations (n=100)**

Knowledge about noise exposure	Frequency	Percentage
Yes	34	34.0
No	66	66.0

**Table-VII: Distribution of the study populations by sound level (n=100)**

Sound level	Frequency	Percentage
<55 dB ( $L_{Aeq,24\text{ hour}}$ )	19	19.0
55-60 dB ( $L_{Aeq,24\text{ hour}}$ )	35	35.0
60-65 dB ( $L_{Aeq,24\text{ hour}}$ )	21	21.0
65-70 dB ( $L_{Aeq,24\text{ hour}}$ )	17	17.0
>70 dB ( $L_{Aeq,24\text{ hour}}$ )	8	8.0

**Table-VIII: Effect of noise on health of the study populations (n=100)**

Effect of noise on health	Frequency	Percentage
<b>Cardiovascular effects</b>		
Ischaemic heart disease	9	9.0
Myocardial infarction	15	15.0
Hypertension	13	13.0
Stroke	5	5.0
<b>Psychological effects</b>		
Anxiety	7	7.0
Depression	12	12.0

Fatigue	3	3.0
Primary insomnia	2	2.0
Impaired concentration	2	2.0
<b>Other effects</b>		
Headache	7	7.0
Visual or hearing impairment	4	4.0
Effect on birth weight	2	2.0
Obstructive sleep apnoea	3	3.0

## DISCUSSION

In current study observed that majority 42(42.0%) populations belonged to age 31-40 years with mean age  $37.5 \pm 11.7$  years. Male were predominant (57.0%). Most of the populations were married (87.0%) and 37(37.0%) populations completed graduate and above education level. Most of the populations were housewife (40.0%) and rest 33(33.0%) were service holder. Jakovljevic *et al.*[9] reported that the mean age was found  $43.5 \pm 14.2$  years, male 35.4%, high school was 46.8%, college degree 20.4%, university degree 33.0%. Physical work was 30.4% and intellectual was 69.4%. Paiva *et al.*[3] also observed similar observation they showed the average age of the population was 49.0 (1.26) years old, 30% elderly (over 60 years), the majority (58.2%) female, 40% single, and 38% married. From the socioeconomic standpoint, most of the population has a high level of education (39% with higher education and 21.5% with a postgraduate education). Basner and McGuire<sup>1</sup> study supported included 33 individuals between the ages of 22 and 68 years (average age 36 years, 67% female). Elmenhorst *et al.*[5] showed that the age averaged  $23.4 \text{ years} \pm 2.3$  (SD) with a range from 20 to 29 years, male was 27 and female 26.

In current study showed aircraft noise was found 28(28.0%), road traffic noise 57(57.0%) and railway noise 15(15.0%). Basner and McGuire [1] reported road, rail, and aircraft events were identified by listening to indoor sound recordings and the start and end of each noise event was scored. Observational studies explored: road traffic noise (29 studies), aircraft noise (8), railway noise (7), and road work noise (1) and blast noise from a military base (1). Experimental studies simulated noise from: road traffic (21 studies), aircraft (9), railways (16) and road work (1). It is estimated that more than 70 per cent of environmental noise (unwanted sound) in urban Australia is due to road traffic [10]. Aircraft operations generate substantial noise, exposure to which is concentrated around airports. Take-off produces intense noise, including vibration and rattle, while landings generate noise in long low-altitude flight corridors. For the most part, larger and heavier aircraft are responsible for more noise than lighter aircraft [11].

In current study showed that mean duration of night sleep was  $6.7 \pm 1.3$  hours, mean difficulty with falling asleep was  $2.3 \pm 0.6$ , mean time needed to fall asleep was  $1.7 \pm 0.9$ , mean sleep quality was  $3.5 \pm 0.7$ , mean use of sleeping pill was  $1.4 \pm 0.6$ . Sleeping by open window 49(49.0%), waking up at night 62(62.0%) and difficulty in falling back to sleep 34(34.0%). Jakovljevic *et al.*[9] reported respondents from noisy area had significantly more difficulties falling asleep, more often reported waking up at night, and had more difficulties in falling back to sleep. They also had significantly poorer sleep quality and more often complained about tiredness after sleep. When asked to specify the causes of sleep disturbances, 48.7% of the respondents from noisy area listed traffic noise, as opposed to only 12.9% of respondents from quiet area ( $\chi^2 = 12.014$ ;  $P < 0.001$ ). Noise was the most important cause of awakenings for 44.4% of respondents from noisy area, compared with 6.1% respondents from quiet area ( $\chi^2 = 22.570$ ;  $P < 0.001$ ). Considering the fact that respondents in noisy area significantly less often slept by open windows in the summer ( $P < 0.001$ ), noise was estimated to be the main cause (83.5%). No significant differences were observed between the respondents according to the residence area in the average duration of night sleep, time needed to fall asleep, and use of sleeping pills.

In this study observed that majority 35(35.0%) patients had sound level 55-60 dB ( $L_{Aeq,24 \text{ hour}}$ ) followed by 21(21.0%) 60-65 dB ( $L_{Aeq,24 \text{ hour}}$ ), 19(19.0%) <55 dB ( $L_{Aeq,24 \text{ hour}}$ ), 17(17.0%) 65-70 dB ( $L_{Aeq,24 \text{ hour}}$ ) and 8(8.0%) had >70 dB ( $L_{Aeq,24 \text{ hour}}$ ). Jakovljevic *et al.*[9] observed that it is caused mainly by road traffic noise; the 24-hour Leq can reach even 75-80 dB(A) along the main roads. More than 30% of Europeans are exposed to Leq exceeding 55 dB (A) at night, which may cause sleep disturbances [1]. Systematic noise measurements in Serbia were performed in four cities with a population over 250 000. These results of follow-up measurements in Belgrade over 30 years showed that outdoor noise levels exceeded the allowed limits on 23 out of 27 measuring sites for 11-16 dB during day and 10-14 dB during night[12]. Paiva *et al.* reported The noise levels at all the measured points were found to exceed the critical level for the area, i.e., 55 dB(A). The mean Leq in the area exposed to traffic noise was 73.1 (dp = 0.6) dB(A), while in the non-exposed area it was 64 (dp = 0.6) dB(A). Chowdhury *et al.*[13] reported that the average maximum sound levels ranged between 65.84 and 79.69 dB, while the average minimum sound levels ranged between 59.73 and 69.03 dB. In the present study, the average noise levels ranged from 67.05 to 73.58, 66.09 to 73.66 dB, 67.93 to 75.44 dB, 67.62 to 74.86 dB, 68.08 to 76.75 dB, 69.03 to 76.45 dB and 67.23 to 79.69 dB respectively at Pahartoli Eye Hospital, USTC Hospital, Halonen *et al.*[14] conducted a cross-sectional study of 7019 adults and found that symptoms of insomnia were significantly higher when road traffic noise measured at a residential façade

exceeded  $L_{night} 55$  dB (odds ratio (OR) = 1.32 [1.05 – 1.65]). Kim *et al.*[15] examined the relationship between exposure to aircraft noise (from a military airport) and sleep quality in a sample of 1982 adults. The results indicated that noise levels (Weighted Equivalent Continuous Perceived Noise Level measured externally) between 60 and 80 dB (OR = 2.61 [1.58 – 4.32]) and > 80 (OR = 3.52 [2.03 – 6.10]) were linked with disturbed sleep.

Basner *et al.*[16] conducted an experimental field study of 64 adults. They found that aircraft noise events that were above 33 dB (measured at the ear) were associated with increased awakenings. Frei *et al.*[17] conducted a study of 1122 adults comparing sleep disturbance using a standardised sleep disturbance score with modelled road traffic noise. This study found that road traffic noise levels > 55 dB LAeq (measured at the residential façade) were associated with a greater prevalence of sleep disturbance.

In current study regarding cardiovascular effect, 15(15.0%) had myocardial infarction, 13(13.0%) hypertension, 9(9.0%) ischaemic heart disease, 5(5.0%) stroke. Regarding psychological effects 12(12.0%) had depression, 7(7.0%) anxiety, 3(3.0%) fatigue, 2(2.0%) primary insomnia and 2(2.0%) impaired concentration. Regarding other effects, 7(7.0%) had headache, 4(4.0%) visual or hearing impairment, 3(3.0%) obstructive sleep apnoea, 2(2.0%) effect on birth weight. Paiva *et al.* [3] reported regard to health, only 25% of the interviewees reported having a chronic disorder such as hypertension, diabetes, depression, high cholesterol and cardiovascular diseases. In response to the question about their hearing, 62.7% stated it was excellent/good, and only 39.6% have had an audiometric evaluation. Most of the study population (55.1%) are aware of traffic noise at home, with 43.1% of the considering the environment to be moderately noisy and 37.8 describing it as very noisy. Cardiovascular disease includes ischaemic heart disease, myocardial infarction, hypertension (high blood pressure) and stroke. The number of epidemiological studies on the association between exposure to road traffic and aircraft noise and hypertension and ischaemic heart disease has increased in recent years. Very few studies have investigated the cardiovascular effects of exposure to rail noise [4]. Chapter 4 addresses noise and cardiovascular disease. Environmental noise is not believed to be a direct cause of mental illness, but it is thought to accelerate and intensify the development of latent mental disorders [11]. The effect of noise is complicated. Research suggests that poor psychological health is associated with greater annoyance responses. Studies in adults have found that noise exposure relates to an increase in reported psychological symptoms such as anxiety and depression, rather than to clinically diagnosable psychiatric disorders. Overall, evidence suggests that in adults and children, noise exposure is unlikely to be associated with serious psychological illness. However,

there may be effects on wellbeing and quality of life [18]. Poor sleep has been linked to numerous adverse consequences, including health conditions such as cardiovascular disease, depression and obesity[19], as well as accidents and disability due to fatigue[20], and lost workplace productivity[21, 22]. These translate into considerable social and economic costs, with three sleep disorders alone – obstructive sleep apnoea, primary insomnia and restless leg syndrome – estimated to cost the Australian economy \$36 billion a year[23]. The economic costs of sleep problems more broadly (such as daytime sleepiness or short sleep) are estimated to be considerably higher [23].

## CONCLUSION

The study evaluated the level of annoyance and sleep disturbance that is perceived by the residents of Niketon Housing Project. It was also provide information about the various sources of environmental noise perceived by the dwellers. It is to estimate any association between noise exposure and annoyance or sleep disturbance. This study showed that the population living in urban area where traffic noise level is above 55 to 65 dB (A) Leq was at a significantly higher risk of the occurrence of sleep disturbances than it was population living in a quiet area.

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