Original Article

ENVIRONMENTAL NOISE AND SLEEP AMONG POPULATION RESIDING NEAR RAILWAY TRACKS

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ABSTRACT

Background: Environmental noise is one of the most important environmental hazards, which have detrimental effects on wellbeing & overall quality of life of people. The aim of this study was to find out the relationship between environmental noise and sleep quality among the population residing in areas adjacent to the railway track.

Methods: A cross-sectional study was conducted from January to December 2023 on 422 people living near railway tracks of Bogura city. Participants were selected using purposive sampling from four sites. Noise levels were measured with a calibrated smartphone app, and socio-demographic data and sleep quality (PSQI) were collected via face to face interviews and semi-structured questionnaires.

Results: The Mean equivalent noise level was found to be 78.83 ± 09.26 dB, with significantly higher levels in blocks closer to the railway (89.83 dB) than those further away (71.55 dB). Poor sleep was more common near the tracks and among men, the elderly, illiterate individuals, farmers, service holders, and those living in their residences for seven years or less. Logistic regression showed, age and noise exposure were significantly linked to sleep quality; each additional year of age increased the likelihood of sleep problems by 1.032 times, and those living near the tracks were 7.4 times more likely to report sleep problems than those living further away.

Conclusions: Environmental noise was found to be associated with poor sleep quality. Effective measures such as use of protective green belt, noise barriers, regular health and noise impact assessment and awareness program may lessen the ill effects.

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INTRODUCTION

Environmental noise is a significant environmental threat in both industrialized and developing nations, originating from diverse sources such as traffic, aircraft, and trains. The primary contributor to environmental noise in urban areas is road traffic[1,2]. The issue of sleep disturbance is frequently reported by those who are subjected to noise pollution, and it can have a substantial influence on both their well-being and overall quality of life. The impact of noise-induced sleep disturbance can lead to several health consequences, including alterations in sleep patterns, increased wakefulness, sleep movement disorders, feelings of tiredness, compromised daily functioning, and reduced cognitive abilities.[1,3]

The town's transportation system, industries, construction sites, marketplace, sound system, and advertisements are the primary causes of noise pollution[2,4]. It is acknowledged globally as an occupational danger that prolonged exposure to loud noises causes noise-induced hearing loss, a hearing impairment that is linked to hypertension, aggression,

disturbed sleep and ultimately decreased productivity and efficiency at work[3,4,5]. While the railway system offers a convenient means of transportation, it is important to acknowledge that the noise and vibrations generated by passing trains might potentially disrupt the daily lives of individuals residing in the vicinity to the railway track.[2,3]

Sleep is an essential physiological process that plays a vital role in the restoration and restoration of the human body[3]. Poor sleep quality has been consistently associated with adverse health outcomes. There is an understanding among health professionals regarding the essential significance of obtaining an adequate amount of restorative sleep for the preservation of both physical and mental well-being. The impact of noise on sleep has been widely recognized, as it has the potential to disrupt sleep patterns and result in substantial fragmentation and deprivation, so adversely affecting both our physical and mental well-being [1,3,8]. Among the various sources of noise, road traffic noise has been identified as the predominant and influential component that significantly impacts the quality of nighttime sleep experienced by people.

Study setting and study population
This was a descriptive type of cross-sectional study, conducted between January to December 2023 among respondents residing in areas adjacent to the railway track of Bogura. The respondents aged ≥18 years and both male and females were included in the study. People with sleep apnoea syndrome were excluded from this study.

Sample size and sampling
A total of 422 respondents were included in the study. Participants were selected by Purposive sampling technique.

Data collection
The measurement of noise levels was conducted at four distinct sites, with each site further divided into two separate blocks. To measure the noise level the smartphone app was calibrated with sound level meter (CFM. DT-8850). Noise measurements were performed in the middle of each block for 3 days per week. (2 working days and 1 Friday). Equivalent Noise Level (Leq) measurements were carried out three hours of monitoring per day. The schedule was as follows: morning 9.00 am-10.00 am, 1.00 pm-2.00 pm and at night 9.00-10.00 p.m.

Equivalent Noise Level (Leq) for every hour was measured by following formula[11]

Equivalent noise level for 1 hour, Leq $(L_1) = L_{50} + [(NC)^2 / 60]$

where, Noise climate (NC) = $L_{10} - L_{90}$

Therefore, considering the essential role of sleep in restoration, noise-induced disruptions of sleep are widely recognized as the most detrimental consequences of noise exposure.[3,9]

Noise and poor sleep both act as barriers to sound mental conditions of people. Considering the findings of various studies on the relationship between health outcomes and exposures of the general population to environmental noise and high level of train traffic noise, the aim of this present study is to investigate the relationship between environmental noise and sleep quality among the population residing in areas adjacent to the railway track. People can be aware of the harmful effects of noise and can use measures which help lowering the environmental noise specifically at night. Findings of this study may have implications for the provision of public health services and contribute to take protective measures for the possible vulnerable groups, especially during sleep.

METHODS

After measuring equivalent noise level for 1-hour, equivalent noise level for that day (3 hours of that day) was measured by following formula
Leq = 10 $\log_{10}$ [t_1 10 L_1/10 + t_2 10 L_2/10 + t_3 10 L_3/10 + …… t_n 10 L_n/10]

Participants' data were collected by direct face to face interviewing of the population of 4 sites residing in the areas adjacent to the railway track of Bogura, who fulfilled the inclusion criteria. The interviews were taken by researchers at the place of study without disturbing their routine work. The data were collected by a prepared pre-tested semi-structured questionnaire which included socio-demographic characteristics and sleep quality. To assess the sleep quality, the Pittsburgh Sleep Quality Index (PSQI) was used. The Pittsburgh Sleep Quality Index (PSQI) is a self-report questionnaire that assesses sleep quality and disturbances over a 1-month time interval. The instrument consists of nineteen individual items and generates seven component scores. The sum of scores for these seven components yields one global score which is assessed with "good" sleepers and "poor" sleepers. The questionnaire had been used in many settings, including research and clinical activities. Data collection instruments were finalized by necessary corrections and modifications based on the findings of pre-test. Written informed consent was obtained from the participants prior to interview.

Data analysis
The collected data were checked, cleaned, verified and coded and post coded simultaneously, avoiding

irrelevant and unreliable information and for quality management then entered into SPSS (Statistical package for social science) version 27software. Analysis was done according to the objectives. For descriptive statistics-frequency, percentage, mean and standard deviation (SD) were used for socio-demographic factors such as age, sex, educational qualification, marital status, occupations, monthly family income, and years of living in current residence. Frequency, percentage, mean, standard deviation (SD) was used for determination of sleep quality and measurements of noise levels.

Ethical Consideration

The study received ethical approval from the Institutional Review Board of NIPSOM in Bangladesh. After detailing the aims and process of the study and confirming that there was no risk of bodily, mental, social, or economic harm, informed written consent was obtained from each participant. Each responder volunteered to participate in the study. Privacy and confidentiality were rigorously maintained. Respondents were free to decline participation at any time during the study.

RESULTS

The age of the respondents were between 18 to 65 year and mean age was 44.63 ± 14.83 years. Among the 422 respondents, majority (30.1%) of the respondents were in 31 to 40-year age group followed by age group of < 30 years (19.2%) and 41-50 year (18.2%) age group. More than half (55.2%) of the respondents were female and the rest (44.8%) of them were male. Among all the respondents, majority of them (41.7%) can do signature only followed by primary education (23.7%), secondary educational level (13.3%). Among them (11.1%) completed higher secondary level and (7.8%) completed higher educational level. Very few (2.4 %) of them were illiterate. Majority (83.4%) of them were married and rest (16.6%) of them were single. Mean monthly family income was 11042.65 ± 5474.89 BDT. Majority of them (44.5%) were housewives followed by businessman (16.4%), Laborer (15.4%) and service holders (11.6%). Very few of them were Farmers (7.8%) and students (4.3%). Among all the respondents, majority (63.7%) of the respondents had > 4 members in their family and rest (36.3%) of them had ≤4 members in family. In this study, Majority of the respondents (40.3%) were living for 8-14 years followed by ≤ 7 years (30.3%). Rest (29.4%) of them were living for >14 years in their current residence. (Table 1)

Table 1. Socio-demographic characteristics of the respondents (n= 422)

Socio-demographic characteristics	Frequency	Percentage
Age group (In years)		
< 30	81	19.2
31-40	127	30.1
41-50	77	18.2
51-60	74	17.5
> 60	63	14.9
Mean age 44.63 ± 14.83 years		
Gender		
Male	189	44.8
Female	233	55.2
Educational qualification		
Illiterate	10	2.4
Signature only	176	41.7
Primary	100	23.7
Secondary	56	13.3
Higher secondary	47	11.1
Others*	33	7.8
Marital status		
Single	70	16.6
Married	352	83.4
Monthly income (In BDT)		
≤ 5000	77	18.2
5001-10000	158	37.4

10001-15000	129	30.6
> 15000	58	13.7
Occupation		
Housewife	188	44.5
Businessman	69	16.4
Service Holder	49	11.6
Student	18	4.3
Laborer	65	15.4
Farmer	33	7.8
No. of Family member		
≤ 4	153	36.3
> 4	269	63.7
Duration of living in current residence (In years)		
≤ 7	128	30.3
8-14	170	40.3
> 14	124	29.4
Mean years of living in current residence		11.76 ± 6.90

*Others = (masters-9, Graduate-24)

Equivalent noise level (Leq) of site A, Site B, Site C, site D were 80.55 dB, 81.67 dB, 82.22 dB and 78.33 dB respectively. Maximum Leq was 82.22 dB in site C and minimum Leq was 78.33 dB in site D. Mean of Leq was 78.83 dB. Average Equivalent noise level (Leq) of Proximal and Distal block were 89.83 dB and 71.55 dB respectively. Maximum Leq was 91.60 dB and minimum Leq was 67.62 dB and Mean of Leq of block was 78.83 ± 09.26 dB, which is more than the recommended level. (Table 2)

Table 2. Distribution of equivalent noise level

Site	Block	N	Measured Leq (dB)	Standard noise Level for mixed area(dB)*
Site A	Proximal	35	88.48	
	Distal	66	72.63	
Site B	Proximal	48	89.04	
	Distal	59	73.14	50-60
Site C	Proximal	46	90.20	
	Distal	62	72.84	
Site D	Proximal	39	91.60	
	Distal	67	67.62	

*Bangladesh Noise pollution (control) rules, 2006

In total 422 respondents more than half (52.1%) of the respondents had good sleep quality and a considerate number (47.9%) of respondents had poor sleep quality. (Figure 1)
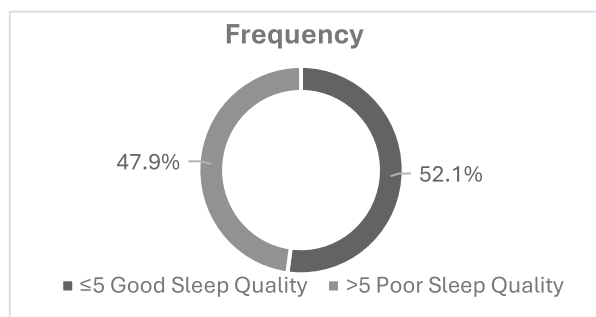

Figure 1. Distribution of respondents by sleep quality with PSQI score

Good sleep quality was higher in < 30 years (61.7%) age group and 31-40 years (55.1%) age group. Poor sleep quality is higher in elderly; as in > 60 years (65.1%) age group followed by 51-60 years (48.6%)

age group and Poor sleep quality is higher (51.3%) in male. Statistically significant relationship was found between age and sleep quality (p= 0.027). Poor sleep quality was higher among illiterate (70%), signature only (50%) and others (51.5%). Almost half of both married and single people experienced Poor sleep quality, in singles (48.6%) and married (47.7%). Good sleep quality is higher in married (52.3%). Poor sleep quality is higher in family's having ≤ 4 members (51%) and Good sleep quality is higher in family having > 4 members (53.9%). This study revealed Poor sleep quality was higher (56.9%) in >15000 BDT

income group followed by ≤5000 BDT (55.8%) income group. On the other hand, good sleep quality is higher (61.2%) in 10001-15000 BDT income group. Poor sleep quality was higher (62.5%) in respondents who were living for ≤ 7 years in their current residence. Statistically significant relationship was found between age, marital status, occupations, duration of living in current residence and sleep quality (p= <0.001, p= 0.032, p=0.035, p = <0.001). (Table 3)

Table 3. Association between Socio-demographic characteristics of the respondents and sleep quality

Socio-demographic characteristics	Sleep quality*		Test of significance
	≤5 good sleep quality	>5 poor sleep quality	
Age group (In years)			
< 30	50 (61.7)	31(38.3)	F=10.931 p= 0.027
31-40	70 (55.1)	57 (44.9)	
41-50	40 (51.9)	37 (48.1)	
51-60	38 (51.4)	36 (48.6)	
> 60	22 (34.9)	41 (65.1)	
Gender			
Male	92 (48.7)	97 (51.3)	χ2=1.638 p= 0.201
Female	128 (54.1)	105 (45.1)	
Educational qualification			
Illiterate	3 (30)	7 (70)	F=3.582 p= 0.617
Signature only	88 (50)	88 (50)	
Primary	56 (56)	44 (44)	
Secondary	30 (53.6)	26 (46.4)	
Higher secondary	27 (57.4)	20 (42.6)	
Others*	16 (48.5)	17 (51.5)	
Marital status			
Single	36(51.4)	34 (48.6)	χ2 = 0.017 P= 0.897
Married	184 (52.3)	168 (47.7)	
Monthly income (In BDT)			
≤ 5000	34 (44.2)	43 (55.8)	F= 8.139 p= 0.043
5001-10000	82 (51.9)	76 (48.1)	
10001-15000	79 (61.2)	50 (38.8)	
> 15000	25 (43.1)	33 (56.9)	
Occupation			
Housewife	97 (51.6)	91 (48.4)	F= 15.859 p= 0.007
Businessman	37 (53.6)	32 (46.4)	
Service Holder	23 (46.9)	26 (53.1)	
Student	14 (77.8)	4 (22.2)	

Laborer	40 (61.5)	25 (38.5)
Farmer	9 (27.3)	24 (72.7)
No. of Family member		
≤ 4	75 (49)	78 (51)
> 4	145(53.9)	124 (46.1)
Duration of living in current residence (In years)		
≤ 7	48 (37.5)	80 (62.5)
8-14	96 (56.5)	74 (43.5)
> 14	76 (61.3)	48 (38.7)

Right column spanning cells: No. of Family member → $\chi 2=$ 0.932, P=0.334. Duration of living → F= 16.432, p= <0.001

*Percentage in parentheses

Analysis of variance showed that there was statistical significant difference of Equivalent noise level (Leq) of respondents of site B and site D, and of site C and site D, where F= 8.469 and p= <0.001. Post HOC tests showed that the mean difference Equivalent noise level (Leq) of site B and site D was 5.29, which was significant (p= <0.001). Between site C and site D, the mean difference was 5.32, which was also significant (p=0.001). But there was no statistically significant difference at the level of p<0.05 in Pittsburgh sleep quality score of respondents of 4 different sites. This study also showed that Equivalent noise level (Leq) of the respondents of proximal block was statistically different from those of distal block (t=95.228 and 107.354, p= < 0.001) and there was statistically significant difference at the level of p<0.05 in Pittsburgh sleep quality score of respondents of proximal block from those of distal block, (t=17.761 and 18.611, p= < 0.001).(Table-4)

Table 4. Difference in Equivalent noise level and sleep quality among respondents of different blocks

	Area block	N	Mean ± SD	Equal variance	t – test	for equality	Of means
					t	df	sig
Pittsburgh Sleep Quality score	proximal block	168	0.88±0.325	Equal variances assumed	17.761	420	<0.001
	distal block	254	0.21±0.410	Equal variances not assumed	18.611	406.459	<0.001
Equivalent noise level	proximal block	168	89.95 ±1.18	Equal variances assumed	95.228	420	<0.001
	distal block	254	71.47 ±2.32	Equal variances not assumed	107.354	398.569	<0.001

In this study, direct logistic regression was performed to assess the impact of a number of factors on the likelihood that respondents would report that they had a problem with their sleep and there was significant relationship with age and for every additional year of age, respondents were 1.032 times more likely to report sleep problem and respondents who were exposed to noise level of proximal block were 7.40 times more likely to report sleep problem than that of distal block. (Table 5).

Table 5. Logistic regression predicting likelihood of reporting sleep quality

	B	S.E.	Wald	df	p	Odds ratio	95% C.I. for odds ratio	
							Lower	Upper
Proximal block	2.001	0.238	70.581	1	<0.001	7.400		
Distal block	-1.309	.153	72.894	1	<0.001	0.270		
age of the respondent	.034	.013	6.883	1	.009	1.035	1.009	1.061
sex of the respondent	.005	.292	.000	1	.986	1.005	.567	1.780
educational qualification of the respondents	.003	.006	.369	1	.543	1.003	.992	1.014
marital status of the respondent	-.038	.162	.055	1	.815	.963	.701	1.323
number of family member	-.132	.120	1.218	1	.270	.876	.692	1.108
monthly income in taka	.000	.000	.460	1	.498	1.000	1.000	1.000
occupation of the respondent	.005	.006	.748	1	.387	1.005	.994	1.016
years of living in current residence	.002	.020	.011	1	.916	1.002	.964	1.042
Constant	2.804	7.340	.146	1	.702	16.506		

DISCUSSION

Based on results found in different studies, it is evident that Environmental noise is associated with poor sleep quality which is responsible for other ill health effects in people. The study aimed to explore the relationship between Environmental noise and sleep quality among population residing in areas adjacent to the railway track.

In this current study, the age of the respondents mean age was 44.63± 14.83 years. In another cross-sectional study Mean age was 46 ±9.7 year which is similar to the current study.[4]

Current study shows, from 422 respondents more than half (55.2%) of the respondents were female, other study also found that about 59% of respondents were female[1]. In this study, among all the respondents, majority of them (41.7%) can do signature only followed by primary education (23.7%). Very few (2.4%) of them were illiterate. In another study 45.5% had certificate/diploma as their highest level of education and 48.1% respondents reported having bachelor or post graduate degrees, which may be due to literacy difference in developed and developing countries.[5]

This current study revealed that, among all the respondents, majority (83.4%) of them were married, had monthly income between 5001 to 10000 BDT (37.4%), housewives (44.5%) followed by businessman (16.4%), had > 4 members in their family

(63.7%), living for 8-14 years (40.3%) in their current residence. Various studies showed similar findings. [1, 6]

Equivalent noise level (Leq) of every site and block were all higher than the national noise limit standard value. Other studies also showed similar findings. [3, 6]

In total 422 respondent's half (52.1%) of the respondents had good sleep quality and a considerate number (47.9%) of respondents had poor sleep quality. Another study showed about 49% of the participants reported that they suffer from poor sleep quality.[1]

In site A, poor sleep quality is higher (53.5%) and good sleep quality was higher in other 3 sites. Poor sleep quality was 53.5% in site A, 47.7% in site B, 48.1% was in site C and 47.9% in site D. Poor sleep quality is high (88.1%) in proximal block and low (21.3%) in distal block. Poor sleep quality was higher (53.8%) in respondents who were exposed to noise level >60 dB. Statistically significant relationship was found between level of noise exposure and sleep quality (p= <0.001). In a community-based cross-sectional study Exposure to noise was positively associated with sleep disturbance, which is similar to this current study.[7]

Good sleep quality was higher in < 30 years (61.7%) age group and 31-40 years (55.1%) age group. Poor sleep quality is higher in elderly; as in > 60 years (65.1%) age group followed by 51-60 years (48.6%) age group. Statistically significant relationship was

found between age and sleep quality (p= 0.027) and poor sleep quality found to be higher in male (51.3%), similar results found in a study in Korea, 2019 [2] and findings dissimilar to the study found in Japan, 2021.[8]

Good sleep quality is higher in married (52.3%), though the percentage were not same, but another study found that married people reported higher percentage of good sleep quality than single[9]. In this study, Poor sleep quality was higher (62.5%) in respondents who were living for ≤ 7 years in current residence. Respondents living for ≤10.5 years in the current residence had higher sleep disturbance (62%).[2]

This current study showed Statistically significant relationship was found between age, marital status, occupations, duration of living in current residence and sleep quality, reasons of sleep disturbances (p= <0.001, p= 0.032, p=0.035, p = <0.001, <0.001). A previous community-based cross-sectional study showed statistically significant relationship was found between age, duration of living and sleep quality (p= <0.001, p= 0.011 and <0.001).[7]

In this study, direct logistic regression was performed to assess the impact of a number of factors on the likelihood that respondents would report that they had a problem with their sleep, this study shows that there was no significant relationship between sex, educational qualification, marital status, monthly income, occupation and duration of living in current residence. But there was significant relationship with age and for every additional year of age, respondents were 1.032 times more likely to report sleep problem and respondents who were exposed to noise level of proximal block were 7.40 times more likely to report sleep problem than that of distal block, which is dissimilar with another study [10] that may be due to their study population was students and this current study was carried out in the community.

In this study, the sample size was collected from a particular area, so the findings of the study was not representative of the whole population in the country & Information was recorded by asking questions not by observation, so they may modify the actual problem.

CONCLUSION

Noise is a widespread, inevitable, and ever-increasing environmental problem in urban people all over the world. The study findings indicated that the noise levels at each site was beyond the established permissible limits for residential zones as mandated by the government of Bangladesh and prevalence of poor sleep quality is significantly greater in site A and proximal blocks. Use of coping mechanisms, Regular assessments of health and noise impact, more awareness program and more study are required to lessen the ill effects. Improved sleep and day-to-day work are two areas where these findings may impact public health services.

REFERENCE

1. Monazzam MR, Shamsipour M, Zaredar N, Bayat R. Evaluation of the relationship between psychological distress and sleep problems with annoyance caused by exposure to environmental noise in the adult population of Tehran Metropolitan City, Iran. Journal of Environmental Health Science and Engineering. 2022;20(1):1–10.

2. Di G, Zhao C, Lin Q, Fan M. Study on Annoyance and Sleep Disturbance Induced by Combined Noises from Road Traffic and Viaduct Rail Transit. Acoustics Australia. 2019;47(3):229–37.

3. Han ZX, Lei ZH, Zhang CL, Xiong W, Gan ZL, Hu P, et al. Noise Monitoring and Adverse Health Effects in Residents in Different Functional Areas of Luzhou, China. Asia Pacific Journal of Public Health. 2014;27(2_suppl):93S99S.

4. Gerhardt C, Kottwitz MU, Lüdin TJ, Gabriel D, Elfering A. Work and sleep quality in railway employees: an actigraphy study. Ergonomics. 2019;63(1):13–30.

5. Michaud DS, Marro L, Denning A, Shackleton S, Toutant N, McNamee JP. A comparison of self-reported health status and perceptual responses toward environmental noise in rural, suburban, and urban regions in Canada. 2022;151(3):1532–44.

6. Christi FV, Adriyani R. Noise Effect on People Living Near Railroad. KnE Life Sciences. 2019;4(10):179.

7. Kim SJ, Chai SK, Lee KW, Park JB, Min KB, Kil HG, et al. Exposure–Response Relationship Between Aircraft Noise and Sleep Quality: A Community-based Cross-sectional Study. Osong Public Health and Research Perspectives. 2014;5(2):108–14.

8. Morihara T, Yokoshima S, Matsumoto Y. Effects of Noise and Vibration Due to the Hokuriku Shinkansen Railway on the Living Environment: A Socio-Acoustic Survey One Year after the Opening. International Journal of Environmental Research and Public Health. 2021;18(15):7794.

9. Rahman MM, Tasnim F, Quader MA, Bhuiyan MN, Sakib MS, Tabassum R, et al. Perceived Noise Pollution and Self-Reported Health Status among Adult Population of Bangladesh. International Journal of Environmental Research and Public Health. 2022;19(4):2394.

10. Mamun MA, Hossain MS, Kamruzzaman M, Khalil MI, Sikder MT, Manzar MD, et al. Prevalence of Poor Sleep Quality and Its Determinants Among Bangladeshi Students: A Pilot Study. Sleep and Vigilance. 2020; 4:185-193

11. Hunashal, R.B. and Patil, Y.B. Assessment of Noise Pollution Indices in the City of Kolhapur, India. Procedia - Social and Behavioral Sciences. 2012; 37, pp.448–457.