Original Article

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Environmental Noise Exposure and Learning Performance of Secondary School Students

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ABSTRACT

Background: *Noise, inappropriate temperature, insufficient light, overcrowded classes, misplaced boards and inappropriate classroom layout all could be confounding variables distracting students in class. The objective of the study to emphasizes on the effects of classroom noise on student's learning performance, students' perception on noise, internal and external noise levels.*

Materials and methods: *This cross sectional study was conducted from January to December 2018 to assess any relationship between environmental noise level and learning performance of secondary school students, evaluation of various noise descriptors such as L10, L50, L90, Leq, and NC was measured with a smartphone using calibrated sound level meter app. The population of the study included students from class seven to class ten of the academic year 2017-2018 in Dhaka, of whom 580 students from three schools were selected by systematic random sampling.*

Results: *Among the participants 66.6% were male and the rest 33.4% were female aging from 13 to 16 years. In school-2, students of class seven were exposed by highest level of sound 81.08 dB and lowest level was 73.55 dB in class eight classroom. In school-1, highest level of sound was 77.69 dB in class seven and lowest level was 75.99 dB in class nine. In school-3, highest level of sound was measured 78.72 dB in class eight and lowest level was 75.03 dB in class nine.*

Conclusion: *Younger secondary school children appear to be more affected by noise than older students.*

Key words: Exposure; Learning; Noise; Performance; Students.

Introduction

In Dhaka city, noise pollution is considered one of the most harmful pollutions. The uncontrolled noise of Dhaka city has made a serious and vulnerable situation for the dwellers. Mixed areas are used in multidimensional ways, so the degree and intensity of noise pollution is often higher. In this regard, a study has been framed to explore the nature and vulnerability of noise pollution in mixed areas as well as to realize its impacts using GIS (Geographic Information System) approach. This study put an effort to determine the level of noise pollution and its zone of influence to know how far noise is affecting the socio-environment of the study area.[1] In the so-called "silent zones", it does not fall below 55dB even in the morning hours. These findings increased a concern to explore those silent zones and assess the impact of noise in Dhaka city. As it has been suspected for many years that children's learning and memory are negatively affected by noise. Over 20 studies worldwide have shown the negative effects of environmental noise on reading and memory in children: epidemiological studies report the effects of chronic noise exposure and experimental studies report acute noise exposure. Tasks affected are those involving central processing and language, such as reading comprehension, memory and attention. Exposure during critical periods of learning at school could potentially impair development and have a lifelong effect on educational attainment.[2-6] The findings show that noisy conditions have direct negative effects on learning, particularly language and reading development, as well as causing indirect problems to learners by distracting or annoying them. Much of the quite extensive research evidence relating to the issue of noise in education has been produced by studies of the sort mentioned above, focused on relating noise levels

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to particular outcomes. Notably, the results, using both experimental and observational methodologies, are remarkably consistent.

Methods and materials

This cross-sectional study was conducted among the secondary level students of selected schools in Dhaka city, with a sample size of 580, to assess the relationship between environmental noise exposure and the learning performance of secondary school students. The name of the selected schools is Dhanmondi Govt. Boys' High School, Tejgao Govt. Girls' High School and Motijheel Govt. Boys' High School. A pretested structured questionnaire was used for data collection. After that, data entry, analysis, and calculation were completed. The whole procedure was conducted between January to December 2018. The study was done through the collection of data using a questionnaire. No intervention or any other invasive procedure was undertaken. Formal approval of the study was obtained from the Institutional Review Board of NIPSOM. Prior to the initiation of the study, each respondent/participant along with their parents was informed about the research and assured, informed written consent was taken. Participation in the study was absolutely voluntary basis. Prior to the selection of participants each potential participant was provided with a consent form in Bengali.

Noise Exposure Assessment

External noise measurement: Sixty minutes of samples of noise were measured outside each school using a sound level meter app with a smartphone. For security reasons measurements were made off the school premises, where possible outside the noisiest façade, at the curbside of the nearest road. In most cases, this was at approximately 1 m from the nearside lane of traffic. For schools 35 external noise measurement position was at approximately 4 meters from the school façade.

Internal noise measurement: The sixty minutes measurement period was chosen to be typical of the school day when the children would be working in the classroom. Thus, rush hour periods, times when children were arriving at or being collected from school, lunch hours, and times when children were outside in the school playground were avoided.

Results

A detailed analysis of the questionnaire survey conducted to meet the research aim and the objectives are presented in following tables.

Table I Noise levels at different locations of selected schools

Location		School-1 Leq (dB)	School-2 Leq (dB)	School-3 Leq (dB)
Entrance		83.20	81.20	85.20
	1*	75.00*	73.55*	74.84*
	2	68.90	69.05	76.33*
	3*	78.38*	79.00*	66.30
	4*	66.40	78.70*	74.60*
	5*	70.90	75.10*	69.70
	6*	76.69*	80.50	80.20*
Class	7	69.90	67.60	71.40
room no.	8	75.99*	70.20	65.50
	9	67.60	70.00	78.08
	10	76.62	70.50	62.00
	11	72.30	69.90	64.00
	12	65.06	66.60	
	13	62.90		

* Selected classrooms for measurement of noise level for five days a week.

Table 1 shows the noise level at selected schools in different classrooms and entrances. The minimum level of noise in school-1, school-2, and school-3 was 66.60 dB, 65.06 dB, and 62.0 dB respectively. In school-1, four classrooms were identified (1, 3, 6, 8) where noise levels were higher than in other classrooms and the students who belonged to those classrooms were taken as samples. In school-3, four classrooms (1, 2, 4, 6), and in School 2, four classrooms (1, 3, 4, 5) were selected in the same manner.

Table II Average Internal Noise Level (Leq (5d)) in a week at selected classrooms

Name of school	Class room no.	Educational level	Mean Leq (5d) (dB)	n
School-1	1	Seven	77.69	53
	3	Eight	77.38	40
	6	Nine	75.99	58
	8	Ten	76.62	42
School-2	1	Seven	81.04	32
	3	Eight	76.43	46
	4	Nine	76.92	48
	5	Ten	77.29	67
School-3	1	Seven	76.33	49
	2	Eight	78.72	37
	4	Nine	75.03	55
	6	Ten	78.08	50

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Table II shows the average internal equivalent noise level (Leq (5d)) in the school environment. In school-1, the highest level of sound was measured at 77.69 dB in class seven, and the lowest level was 75.99 dB in class nine. In school-2, the highest level of sound was 81.04 dB recorded in class seven and the lowest level was 76.43 dB in class eight. In school-3, the highest level of sound was 78.72 dB in class eight and the lowest level was 75.03 dB in class nine.

Table III Average External Equivalent noise level at selected schools for 5 days in a week

School	Day 1	Day 2	Day 3	Day 4	Day 5
School 1	79.98	80.10	82.91	79.52	84.86
School 2	82.44	85.73	81.55	81.97	82.74
School 3	79.81	81.32	76.09	79.29	77.55

Table III displays average external sound level measures for five consecutive days at selected schools. Here the highest level of sound was recorded 85.73 dB and 81.32 dB at School 2 and School 3 on Day 2. And For School 1 highest recorded sound level was 84.86 dB on the fifth day.

Table IV Distribution of study participants by mean ratings on the "Ease of hearing in school spaces" subscale score

School spaces	School 1 (n=193)		School 2 (n=193)		School 3 (n=194)	
	Mean	SD	Mean	SD	Mean	SD
Corridor	3.24	1.102	3.38	.983	3.73	.760
Classroom	3.76	.982	3.81	.905	4.12	.813
ICT lab	3.23	1.119	3.36	1.052	3.54	.944
Science lab	3.29	1.168	3.28	1.201	3.41	1.396
Assemble hall	3.67	.898	3.70	.856	3.97	.660

Table IV summarizes the distribution of study participants by mean ratings on the "Ease of hearing in school spaces" subscale. Ratings were on a 5-point scale bounded by 1=" Always easy to hear" and 5=" Always hard to hear" in response to the request "Please rate how hard or easy is to hear your teacher in these places around the school". The mean of the subscale score is displayed in terms of reported difficulty of hearing, where a high rating indicated that hearing was difficult in the named space. According to the rating, the classrooms of the three schools are presented as the hardest to hear place among school spaces, where means ratings for classrooms of School 1, School 2, and School 3 were 3.76(±.982),3.81(±.905) and 4.12(±.813) respectively.

Table V Distribution of study participants by the mean ratings on the "Sounds in the classroom coming from inside" subscale

Sounds that coming from inside	School 1 (n=193)		School 2 (n=193)		School 3 (n=194)	
	Mean	SD	Mean	SD	Mean	SD
Students talking quietly to each other	3.24	1.421	3.78	.782	3.45	1.348
Students talking loudly to each other	3.41	1.280	3.58	1.083	3.50	1.243
Students moving around	3.34	1.236	3.28	1.038	3.12	1.265
Computers or other equipment like projectors	3.36	1.381	3.41	1.251	2.97	1.481

Table V displays the frequency ratings by the study participants for sounds categorized according to origin as sounds that come from inside during lessons. Frequency was judged in response to the question "How often do you hear these sounds in your lessons?" on a 5-point scale bounded by 1 = "In none of my lessons" and 5 = "In all of my lessons". As displayed in the table the sound rated as being heard most frequently were those generated by pupils in the classroom which was Students talking loudly to each other; 3.41(±1.280) and 3.50(±1.243) for School 1 and School 3 respectively whereas for School 2 the sound rated as being heard most frequently was while Students talking quietly to each other in the classroom; Mean=3.78, SD=.782.

Table VI Distribution of study participants by the mean ratings on the "Sounds in the classroom coming from outside" subscale

Sounds from outside the classroom	School 1 (n=193)		School 2 (n=193)		School 3 (n=194)	
	Mean	SD	Mean	SD	Mean	SD
Students in the corridor outside your classroom	3.16	1.366	2.98	1.403	3.10	1.314
Students in classroom near your classroom	3.09	1.198	3.05	1.290	3.13	1.292
Teachers in classrooms near your classroom	3.06	1.364	2.93	1.231	2.88	1.350
Sudden unexpected sounds such as banging on the door	3.19	1.279	3.07	1.301	3.06	1.290

Table VI displays the frequency ratings by the study participants for sounds categorized according to origin as sounds that come from outside during lessons.

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Frequency was judged in response to the question "How often do you hear these sounds in your lessons?" on a 5-point scale bounded by 1 = "In none of my lessons" and 5 = "In all of my lessons". As displayed in the table, the sound rated as being heard most frequently were those generated by pupils outside the classroom which was reported by participants of School 3; Mean=3.10(±1.314) and for School 1 and School 2 the sound rated as being heard most frequently was sudden unexpected sounds in the classroom; Mean=3.19 and mean=3.07.

Discussion

Among the 580 respondents, 66.6% were male and the rest 33.4% were female. Most of them 89.1% were Muslim and 9.7% were Hindu. Among the respondents, the majority 66% live in rented houses, and 34% have their own houses. Among them majority 56.8% belong to a nuclear family, rest 43.2% reported to have extended family. In the case of long-standing illness, the majority (99.1%) reported about no such illness. The family income of the respondents was ranging from Tk. 25000 to Tk. 110000 and their mean income was Tk. 46847.49 (±21954.442). The respondents were selected from class seven to class ten. The age of the respondents was between 13 to 16 years and their mean age was 14.5 (±1.384) years. Among the respondents-most (34.1%) were 15 years of age, 21.1% were 16 years of age, 22.7% were 13 years of age and 22.0% were 14 years of age.

Primarily thirty minutes noise level was measured in every classroom attended by the secondary school students. Then noisiest four classrooms were selected where further measurement was conveyed for two hours for five days a week except on national holidays. The measurements were taken in classrooms when occupied with students and were busy with normal classroom activities in the presence of their class teachers. Still, the noise levels were much higher than the recommended level by WHO.[7] The minimum level of noise in school-1, school-2, and school-3 was 66.60 dB, 65.06 dB, and 62.0 dB respectively. In school-1, four classrooms were identified (1, 3, 6, 8) where the noise level was higher than in other classrooms. So the students who belonged to that classroom were selected as participants. In school-2 and School-3, same procedure was followed to select the classrooms. Hourly equivalent noise level twice daily noted as L1 and L2 at 9-10 am and 11-12 pm. Highest level of hourly (Leq) L1& L2 in school-1, school-2 and school-3 was 82.31dB & 86.7 dB ,86.73 dB & 88.13 dB and 82.15 dB & 83.02 dB respectively. From hourly measurement 24 hours noise equivalent level was calculated using the logarithm formula in that selected classroom and the highest and lowest daily noise levels were 69.74 dB & 84.86 dB; 87.49 dB & 73.46 dB and 72.78 dB & 85.73 dB in school-1, school-2 and school-3 respectively. The equivalent noise level in all schools was more than the accepted level of sound in school settings. In school-2, the highest level of sound was 81.08 dB recorded in class seven and the lowest level was 76.43 dB in class eight. In school-1, the highest level of sound was 77.69 dB in class seven and the lowest level was 75.99 dB in class nine. In school-3, the highest level of sound was 78.72 dB in class eight and the lowest level was 75.03 dB in class nine. Whereas, according to DOE perfect sound condition for Bangladesh is 45 dB for the daytime and 35 dB for the night in peaceful areas such as schools and hospitals.[8,9]

Another objective of this study was to investigate secondary school students' perceptions of the acoustical environment of their schools. The informed questionnaire was used to measure secondary school pupils' perceptions of how easy it is to hear in various spaces around their school, the type of sounds they commonly hear during lessons, the incidence with which these sounds occur, and pupils' responses to these sounds in terms of the disruption to learning they cause. In these selected schools, highest rated school space was Classrooms. According to the rating, the classrooms of the three schools are presented as the hardest to hear place among school spaces, where means ratings for classrooms of School 1, School 2, and School 3 were 3.76(±.982),3.81(±.905) and 4.12(±.813) respectively. In another study, it was found that 2588 pupils from different schools in the UK rated dining areas, corridors and sports halls as the most hard-to-hear school spaces.[10-12] The findings of this study also indicated that the negative effects of noise and poor acoustics were felt more by older pupils than by younger pupils. The comparison of noise levels and reading comprehension test scores showed that both external and internal classroom noise has a detrimental impact on reading test scores, with younger children in the school-age range being more affected than older children. The younger children were more affected by higher levels of noise in School 1, School 2, and School 3, while the test scores of the older children were more closely related to minimum noise levels. Again, this suggests that the performance of older children is affected by the noise of individual events such as sirens, lorries or motorbikes passing the schools whereas younger children's performance is much affected by the ambient noise of the classroom. This is consistent with the results of a questionnaire survey into children's perceptions of noise and its effects carried out during the same period, which showed that older children were more aware of external noise and that annoyance was related to external L Max levels

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Conclusion

Development of the surrounding area of the school with the increasing activities in the city such as constructions and traffic which is leading to the noise pollution problem. Measurement of noise in classrooms shows that classroom noise levels are higher than the recommended values, particularly in classrooms without acoustic treatment, and that this is often due to the noise of classroom activity as well as traffic noise. This study has shown that chronic exposure to both external and internal noise has a detrimental impact on the score on the reading comprehension test of secondary school students. Younger secondary school children, around 13 years of age, appear to be more affected by noise than older students. Children are also sensitive to noise during learning activities at school.

Recommendation

There is a need to evaluate a) sound insulation programs and b) policies to reduce noise exposure in schools. Studies are required to pile a more precise insight into the mechanisms that underlie noise effects on children.

Disclosure

All the authors declared no competing interest.

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