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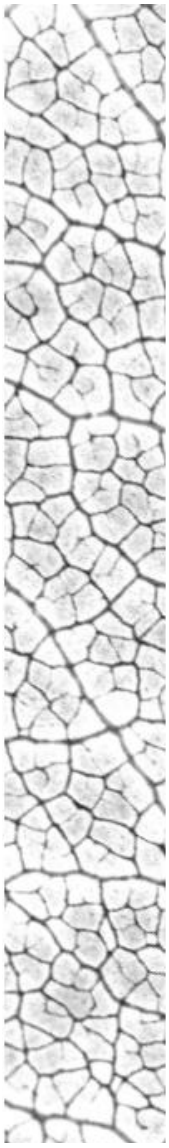

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The impact of noise pollution on schools' students of Basra city, Iraq: A Health study

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Abstract

The purpose of this study was to determine noise levels (LA_{eq}) indoors and outside classrooms in different schools depending on the stage, gender, and course time. Noise pollution has harmful effects on the learning and comprehension of younger students. High LA_{eq} and poor acoustics can cause numerous problems for teachers and students. The conditions of classrooms are important in the students' learning process. We took 135 noise measurements in and near selected classrooms at 12 schools (primary and intermediate) in Basra City, Iraq. Noise parameters analysed were LA_{eq} (including maximum and minimum); noise pressure levels higher than during 10%, 50%, and 90% of the total measurement time; and noise pollution. We discovered that the average equivalent LA_{eq} inside classrooms, in school corridors, and outdoors alongside streets during active teaching were 72.41 dBA, 75.50 dBA, and 63.33 dBA, respectively. We found that the indoor LA_{eq} and background LA_{eq} when not in active-teaching mode (>34.2 dBA) demonstrate that outdoor noise sources do not significantly influence indoor LA_{eq}. Analysis of means between equivalent LA_{eq} in classrooms of boys' schools and girls' schools showed a significant difference, especially in primary and intermediate schools. The LA_{eq} in classrooms and outdoors at the schools were higher than the upper limits recommended by the World Health Organization for learning situations. On the basis of the results of our study, site choice, improved acoustics, and control of teaching LA_{eq} for selected schools are suggested.

Keywords: sustainability, public school, indoor conditions, street traffic noise

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INTRODUCTION

At present, many schools are located in crowded places in cities, such as near markets and restaurants, owing to the lack of available sites or because of the rapid development of nearby potential school sites. Schools should be in a quiet environment because the noise in the school environment affects activities within the school (Bulunuz and Bulunuz, 2017; Ibrahim and Richard, 2000; Punzalan, 2020; Rosen, 2020). Environmental education indicates how individuals and societies build social principles, knowledge, skills, attitudes, and competencies directed toward environmental conservation. Noise is defined as unwanted sound with high-energy waves, which has a major effect in the school; it is measured in weighted decibels (dBA) using a specialized meter. Noise is one of the most important factors having a negative impact on the school atmosphere and learning environment (Tavşanlı et al. 2017). The noise level (LA_{eq}) should be in the range 40–50 dBA in and around schools (Schlittmeier et al. 2008).

Noise pollution refers to diverse sounds in a place that prevents hearing the sounds intended to be heard, and it has a negative impact on human health (Sagar and Rao, 2006). It is the most common cause of hearing loss; patients may not realize when their hearing loss has become acute and beyond treatment or cure (Caciari et al. 2013). Noise affects human health in terms of physical, physiological, and psychological aspects of performance (Muhammad et al. 2017). Physical problems in hearing loss arising from damage to the inner ear because of pressure from sound; physiological effects include increased blood pressure and/or problems in the circulatory system that lead to accelerated breathing and further adverse reactions (Hustim et al. 2018); and psychological issues may surface as noise leads to effects such as stress, poor coping, and other mental-health challenges (Suldo et al. 2008).

One of the places where high levels of noise can have a significant effect on public health is schools. Previous research conducted in Turkey's big city schools

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has demonstrated that loudness is quite high. They found that equivalent noise levels in schools during course hours ranged between 51 and 83.3 dB, and were 72.48 dB in average (Tavşanlı et al., 2017). Golmohammadi et al. (2010) described that Poor acoustical condition and high noise levels can cause many problems for the instructors and students in the schools of Tehran. Much research has been done on noise pollution in a school environment. Negative impacts of noise pollution on students' performance may occur from nearby traffic, airports, or industrial areas (Ibrahim and Richard, 2000; Ikenberry, 1974; Shield and Dockrell, 2003). Ali et al. (2018) explained that Baghdad region's nature, suffers from population explosion, this reflected in the schools located in this city are also suffering from exceeding of the limit allowed in the classroom and applies to most schools in the area.

The important point to control noise pollution is to measure noise pressure level and the considered parameters and to compare it with standard parameters. Our aim in this study focused on the problem of noise pollution in schools and their surroundings because of the lack of studies in this field.

MATERIALS AND METHODS

Basra is an Iraqi city located on the Shatt al-Arab River in southern Iraq between Kuwait and Iran. It had an estimated population of 1.33 million in 2018. Our study included measuring LA_{eq} in different parts of 12 school buildings in Basra City. For study subjects, we randomly sampled 135 classrooms in six primary schools (three for girls and three for boys) and six intermediate schools (three for girls and three for boys), with students' ages ranging from 7 to 15 years. There were 30–35 students per classroom, and classroom areas were roughly 19–29 m^2.

The sample size was chosen on the basis of the results of related studies of sound levels in classrooms (Ismail et al. 2015) with a sample error of $\pm$5% (95% confidence interval). Samples also were selected regarding gender, type (grade), and nearby traffic load. For each studied school, we assessed equivalent sound pressure levels among measurements made inside the classrooms and outdoors. For this purpose, we aimed to measure noise indicators and noise-pollution levels (NPLs) in a location inside classrooms. Noise parameters assessed in this study included LA_{eq}; noise pressure levels higher than during 10%, 50%, and 90% of the total measurement period (L_{10}, L_{50}, and L_{90}, respectively); and NPL for each location. For noise pollution, we used the equation:

$$NPL = LA_{eq} + (L_{10} - L_{90}) \quad (1)$$

We used Microsoft Excel 2016 to calculate all noise parameters. Using the built-in calibration system, we calibrated the LA_{eq} measuring device daily before starting to measure. Measurements were taken between 8:30–11:30 a.m. Sundays through Thursdays and at various times on Fridays and Saturdays from 15/11/2016 through 15/4/2017.

Table 1. Parameter of noise level (in dBA) in studied schools, Basra City, Iraq

Location	Range	Mean	±SD
Classrooms (during active teaching)	52.9–93.7	72.41	8.59
Corridors (during active teaching)	63.5–88.6	75.5	7.02
Outdoors (near street, during active teaching)	50.0–75.8	63.33	8.84
Classrooms (not during active teaching)	32.0–35.0	34.2	5.93

In each school, a classroom was randomly selected for each stage, and the sound level was measured during active teaching in the middle of a classroom. LA_{eq} was measured by prior-calibrated sound level meters (QUEST 2700) per ISO 1996-1 (ISO/TC 43/SC 1, 2007) at the students' hearing height in classrooms and school corridors, at least 1 m from any reflecting wall. The data were analyzed using Statistical Package (SPSS) software; variable means were compared by T-test analysis; and analysis of variance (ANOVA) was used for regression analysis.

RESULTS AND DISCUSSION

We found that the average equivalent LA_{eq} inside classrooms during active teaching was 72.41 dBA. The detected mean background LA_{eq} outdoors was lower than in classrooms in active-teaching mode. The average background LA_{eq} in classrooms (when students were silent) was 34.2 dBA. The results (**Table 1**) show that LA_{eq} at different schools in Basra City was high and exceeded the recommended limits set by the World Health Organization (Winblad et al. 1997). The American Speech-Language-Hearing Association (ASHA Working Group on Classroom Acoustics, 2005) also suggests that it should not exceed 50 dB for a classroom containing students.

In comparison noise pollution in schools between indoor LAeq and Classrooms, in the non-teaching state (background) showed that outdoor noise sources could not affect indoor noise levels, so inside sources were the main sources for noise pollution (Astolfi and Pellerey, 2008; Golmohammadi et al. 2012). This is due to the students' overcrowding and traffic congestion of the student and staff transport near the school entrance and the central street location. Average LAeq data for different classroom stages and for students (grade levels) in both girls' and boys' schools show no clear trends that could be used to differentiate the samples into groups (**Fig. 1**). All collected data have a normal distribution of equivalent NPLs in classrooms during active teaching (**Fig. 2**).

Data comparing NPLs in schools from indoor LA_{eq} (during active teaching) and classroom background levels (not during active teaching) showed that outdoor noise sources did not affect indoor LA_{eq}, thereby implicating inside sources as the main causes of noise

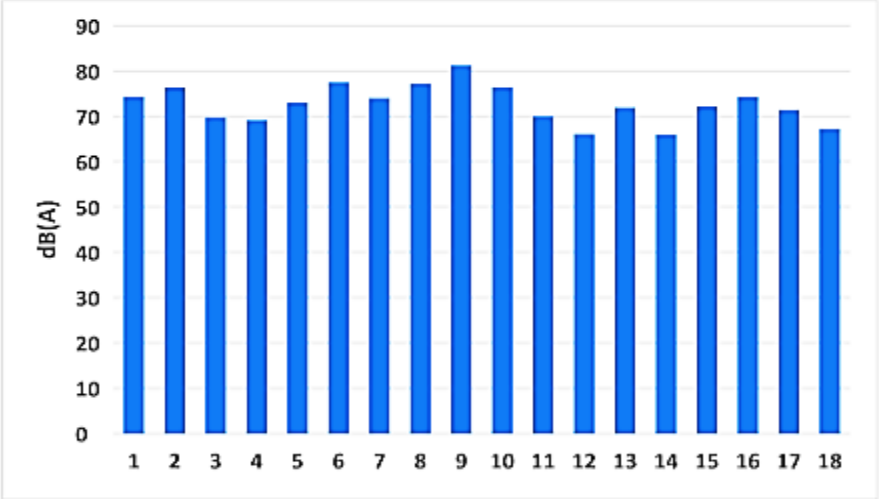

Fig. 1. Equivalent noise-pollution levels in all classrooms (during active teaching)

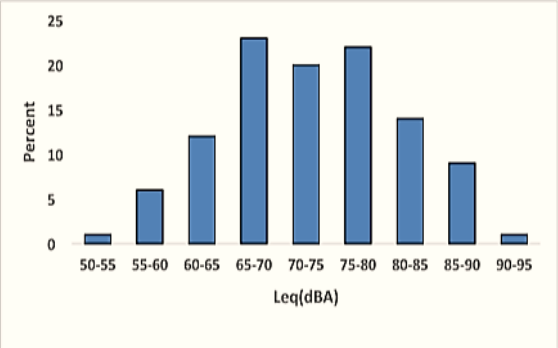

Fig. 2. Distribution of equivalent noise-pollution levels in classrooms (during active teaching)

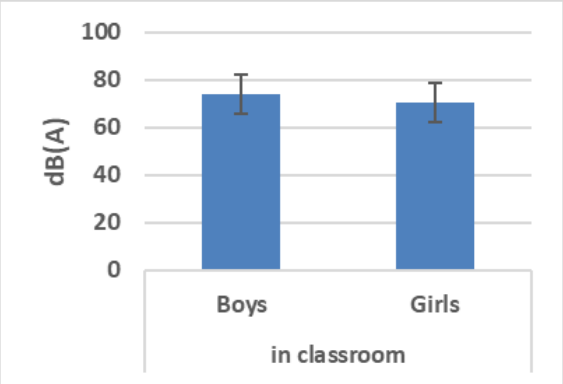

Fig. 3. Variation of equivalent noise-pollution levels in classrooms during active teaching of girls and boy students

pollution in schools (Astolfi and Pellerey, 2008; Golmohammadi et al., 2012). We also examined relationships among LA_{eq}, student gender, and school stage. The results (**Fig. 3**) indicated that there was a difference between girls' and boys' schools: the latter had a higher average NPL, 60.3 dBA, but it was not statistically significant. Ali et al (2018) mentioned that female schools were lower in noise pollution than male schools in Baghdad city.

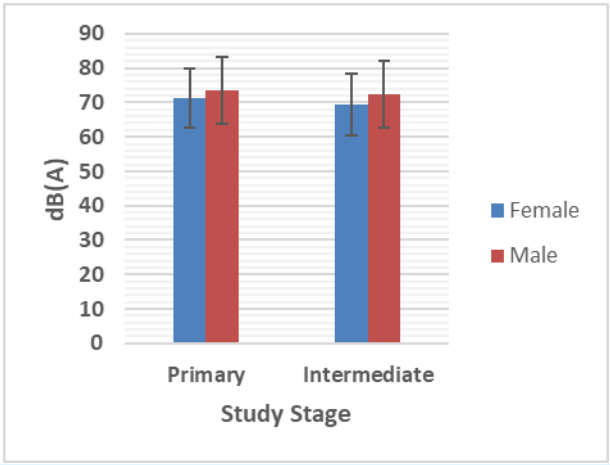

Fig. 4. Variation of equivalent noise-pollution levels in classrooms during active teaching of female and male students at different stages

We found variations in LA_{eq} within the classrooms during active teaching, but there were no significant differences between the study stages owing to the teaching methods and loud interaction between teacher and students (**Fig. 4**).

We also found that the average LAeq was highest in spring-term classes (76.70 dBA) and lowest in autumn (68.32 dBA). The results (**Fig. 5**) showed a statistically significant difference between autumn and spring classes. This may be explained by the association of spring with vitality and activity after inactivity in winter, with increased student energies applied to study because the weather is appropriate. (Beşoluk and Önder, 2011) noted that seasonal changes might affect the achievement of students had higher scores in the spring.

Our results indicate that chronic exposure to high LA_{eq} affects learning skills. High levels of sound interfere with speech communication, not only leading to worse comprehension for both of student and teacher (Woolner

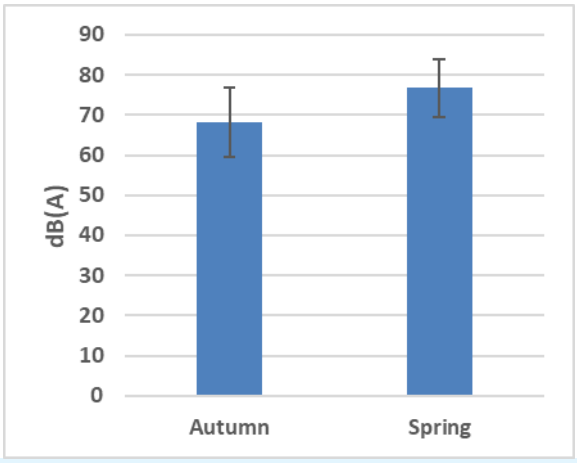

Fig. 5. Variation of equivalent noise-pollution levels in classrooms in both autumn and spring courses (during active teaching)

and Hall, 2010; Sala and Rantala, 2016) but also possibly encouraging the students to speak to each other more. Children suffer from noise-induced hearing impairment, reduced reading comprehension, and caused a delay in reading skills development (Stansfeld et al. 2005).

When we compared LA_{eq} data recorded in the classroom and outside (on the school grounds) with WHO standards, the levels were found to be unacceptably high. According to the WHO, noise levels should not exceed 35 dBA in the classroom and 55 dBA in the building but outside the classroom (such as in the corridors). Outside (on school grounds), the WHO limit is 60 dBA if along a main street or 40 dBA if in a residential area. LA_{eq} measurements in classrooms of primary and intermediate schools were found to be higher than what WHO recommends for learning environments (Winblad et al. 1997).

CONCLUSION

High NPLs have many causes, including high-density classrooms, nearby commercial markets, building shape or configuration, and school location. Our results showed that a transmission loss could be achieved by separating the classroom by erecting walls. Therefore, site choice improved acoustic quality, and controlling teaching-noise level must be considered in future building of schools.

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