Evaluation of Noise Levels affecting Schools in Cairo - Egypt

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Abstract

Educational institutions and Schools are among the sensitive areas that have to be protected from high noise levels which adversely affect students and hinder the process of their education in terms of speech interference, disturbance of information comprehension, message communication and annoyance. The WHO guidelines issued in 1999 has recommended 35 dB LAeq for the background sound pressure level during teaching sessions in order to be able to hear and understand spoken messages in classrooms. For outdoor playgrounds it has recommended 55 dB LAeq for the sound pressure level of the noise from external sources, which is the same value given for outdoor residential areas in daytime.
The EEAA through its Noise Monitoring Network monitored the noise levels in 9 sites of educational institutions in Cairo City, which were mainly affected by noise from road traffic. Results revealed that noise levels ranged between 73 – 78 dB during day time. All monitored levels exceeded the recommended limits and the levels set in the executive regulation concerning the area classification. Recommendations and noise reduction measures have been proposed to protect these schools from high noise levels. The recommendations also, included the necessity of land use planning regarding placement of schools and educational institutions in the sensitive areas, and preparing environmental impact assessment studies for the educational institutions allocation as well as considerations of engineering measures for noise protection.
Based on the results of this study, The Egyptian Environmental Affairs Agency was recently recommended the noise limits for educational institutions among many other limits for indoors and outdoors activities in the amendment of the executive regulation of environmental law no 9/2009. The recommended limits were 40 dB LAeq in classes and 55 dB LAeq for outdoor playgrounds.

1 Introduction

Every child has the right to grow up and live in a healthy environment to live, learn and play in healthy places. Children are the most vulnerable population group to unhealthy environments that contribute to about one third of the total burden of diseases among children per year, world wide. Various factors are considered as the major environmental health problems affecting children. Noise as a ubiquitous environmental pollutant, is a public health issue because it leads to annoyance, reduces environmental quality, and might affect health and cognition in children [1].

The problem with noise is not only that it is unwanted, but also that it negatively affects human health and well-being. Harmful effects of noise on human consist of auditory and non-auditory effects. Auditory effects are physical effects of noise, like hearing loss, hearing impairment, threshold shift or tinnitus. Non-auditory effects of noise are physiological effects (startle and defense reaction leading to potential increase of blood pressure), interference with speech communication, sleep disturbance, psychological effects (headaches, fatigue and irritability), performance effects (task performance, distraction and productivity), annoyance (feeling of displeasure, where tolerances vary enormously and noise impulses are more annoying than a steady noise) [2].

In children, the adverse effects of noise are similar to those with adults, but noise can negatively affect children's learning and language development, it can disturb children's motivation and concentration and can result in reduced memory and in reduced ability to carry out more or less complex tasks [3]. Noise may irritate a stress response in children that includes increased heart rate and increased hormone response, and noise may disrupt sleep and hinder needed restoration of the body and brain. There have been many studies which provide evidence about noise affecting children. In those studies which examine the effects of chronic high levels of environmental noise on school children's cognitive performance and health [4]. For this reason, noise is an important factor for school health. It has been noticed that the noise level inside the schools and classes are frequently evaluated in the literature. Also, the effects of inner environment noise level on students' learning and psychological health are being researched. The students are exposed to inner environmental noise in the school; however, during the breaks, students are exposed to noise in the outdoor environments where they may not be aware of the negative effects. Moreover, if the structural properties of the building are not adequate, outer environment noise can affect the inner environment noise level, and creating an inadequate learning environment [3], [5]. Thus, the outer environment noise level and the factors increasing it are as important as the classroom noise level. Therefore it is necessary to understand the factors that contribute to the increase in noise levels and find the appropriate methods for reducing noise to improve our acoustical environment and guarantee a healthy living for our children [6].

There are several national and international guidelines relating to the acoustics of classrooms. These mainly take the form of recommended values for reverberation time and background noise levels in teaching spaces, together with sound insulation requirements for schools. For example, the World Health Organization WHO Guidelines for Community Noise specify an appropriate background level for classrooms as 35 dB LAeq during teaching sessions. The executive regulations of the environmental law 4/94 include values for noise levels outside schools according to the type of area of the school which is in the range of 50-60 dB LAeq in the day period [7], [8].

With regard to noise levels inside schools, a further problem arises in interpreting previously published data, owing to the lack of a standard method for measuring noise in schools, and the difficulty of deciding what measurement represents a ''typical'' classroom noise level. These problems are acknowledged by Hodgson. And by Picard and Bradley in reviews, published in 1999 and 2001, respectively, of classroom noise surveys. There is a wide range of levels in the published data. For example, Hodgson in summarizing previous classroom noise surveys, dating from 1977 – 1991, found that classroom speech that is, teacher's Levels ranged from 40 to 80 dB, student activity levels from 40 to 70 dB, and ventilation noise levels in class- rooms from 23 to 55 dBA. Similarly, Picard and Bradley noted that reported occupied levels in a full range of class- rooms from kindergarten to university varied from 42 to 94 dBA [9].

In the current study noise levels were measured outside 9 schools in Cairo governorate, to give a general indication of the noise environment around schools in Cairo. Detailed measurements were also made inside these schools to provide data on typical classroom noise levels of primary, prep and secondary school children aged between 4 and 16, and to enable a comparison of internal levels with external levels. The variation of a number of noise parameters throughout the day in 45 classrooms was examined. Noise was also measured in the different floors in the school to determine the influence of external noise on the internal noise environment of the schools as related to the increase in the floor level of the classroom in the school.

2 Effects of noise on Children at School

There has been less research in the past in the effects of noise on children in the classroom, compared to environmental noise. However, research in this area is increasing, where several recent studies have been investigating the effects of internal noise on children's reading, numeracy and overall. It has been found that a significant drop in children's performance, particularly in learning to read, when the background noise level interfered with speech. Children performed better in word intelligibility tests in the acoustically treated rooms. The improvement being particularly marked when other pupils were talking in the classrooms. Similar results were obtained in a study of pre-school children who had been exposed to levels in the classroom of 75 dB (A). Following acoustic treatment to reduce the noise; the children's performance improved in letter, number and word recognition. In contrast, in a study of older children, aged 13 and 15, working in levels of 58 to 69 dB(A) there was poor correlation between sound level and quality of work; however, there was a significant relationship between annoyance and the effect of noise on schoolwork[3],[4],[5],[6].

There is a need for further work to examine the reasons for the effects of noise on children's performance, in particular what aspects of their cognitive processing are affected by different types of irrelevant noise. A number of possible explanations have been proposed. The cognitive coping hypothesis suggests that children deal with excessive levels of environmental sound by tuning it out. This, it is argued, results in indiscriminate tuning out of all stimuli resulting in generalized poor learning. This explanation would imply that a full range of cognitive tasks would be affected, and this is not what appears to happen. In contrast increased arousal could have the effect of increasing performance on tasks where irrelevant items are screened, but continued high levels of arousal may result in an inability to concentrate. More recently the effects of environmental noise have been conceptualised in terms of helplessness. However, both the arousal and the learned helplessness hypotheses fail to make clear predictions about the ways in which environmental noise will differentially affect cognitive skills [3]. A criticism of studies of the effects of irrelevant noise on adults is that they have mainly involved the performance of simple laboratory tasks in background noise or a marked exception to this is the work who examined the disruption of office related tasks by speech and office noise, and confirmed the negative effect of noise exposure on more complex cognitive tasks. However, results obtained with adults cannot necessarily be generalized to children as children's cognitive and linguistic skills are less developed than those of adults. Shield et al carried out a series of experimental investigations in schools to examine the ways in which different irrelevant sound sources interfered with children's processing of verbal and non-verbal tasks. They found that children's talk in the classroom had a detrimental effect upon the verbal (reading) task but that the addition of random environmental noise events improved performance on this task. A non-verbal task speed of processing was detrimentally affected by both classroom talk and environmental noise individually; the worst performance occurring in a combination of these two sounds [3], [9], [10]

The most widespread and well documented subjective response to noise is annoyance. However, while there have been many studies concerned with annoyance caused to adults by different types of noise, including the ones which have established dose response relationships between noise and annoyance. Children's annoyance due to noise is a relatively less researched area. Yet children's annoyance may be an important factor in determining the effects of noise; however, there was a significant relationship between the children's annoyance and the effect of noise on schoolwork [3], [11].

3 Methodology and Instrumentation

In this study, the measurements were recorded in a total of 9 schools to determine the outdoor noise level of these schools, and also the indoor noise levels in the classrooms and playgrounds. These schools had been selected to represent educational institutions in different regions (residential area – commercial area – areas located on main roads) in Cairo Governorate. These schools are exposed to different kinds of noise sources such as the traffic noise, workshops and commercial activities.

The measurements of outdoor noise (environmental noise) surround the schools were conducted for a period of one month including school time (March 2009), and these measurements has been followed the standards of ambient environmental noise (ISO 1996 part1, 2) [12].

A noise measurement were conducted in the schools classrooms for one hour in each school (from 10am until 11am), this measurement period was chosen to be during teaching hours in the classrooms and the environmental noise parameters (LAeq, LAmin and LAmax) were recorded at each classroom inside the schools.

The devices of the sound level meter which used in the measurements are:-

1- Noise monitoring terminal type 3639E (For the ambient Environmental noise).

2- Bruel & Kjaer sound level meter, with frequency analyzer type 2250 (For the interior noise).

3- Bruel & Kjaer calibrator, type 4231

The results of the outdoor measurements were compared to the permissible limits of the different zones which were set in the executive regulation of environmental law of 4/1994 and it is shown in the following table [8]:-

Area classification	Permissible Limit for Noise Levels dB(A)		
	DAY	EVENING	NIGHT
Commercial, administrative and downtown areas	65	60	55
Residential areas with some workshops or commercial establishments or which are located on a main road	60	55	50
Residential areas in the city	55	50	45
Residential suburbs with low traffic	50	45	40

Table 1: The permissible Limits of Noise Levels for the different Regions

The measurements of the outdoor noise levels of the schools were taken for one month. March 2009 was chosen as a typical month of the school year. This measurement is conducted using noise monitoring Terminal (Bruel and KJaer Type 3639E). For security reasons, measurements were made off the school premises and the terminals were installed on the fence from the exterior of the school wall and the microphone was at a height of approximately 4 meter from the ground [8].

When measuring noise in schools, it was decided that the most appropriate technique for the measurements of noise was the use of handheld sound level meter. Short three minutes sample of noise in five classrooms in each school gave good indication of the fluctuation in the noise levels through each school.

The Overall aim of the study utilizing this survey was to evaluate the environmental noise and its effects upon the children in schools. It was therefore necessary to survey schools subjected to a wide range of noise levels. Some schools in Cairo are subject to high levels of noise being located close to main roads or commercial area, whereas other schools are sheltered from road traffic noise by surrounding building, or were set back from the road, separated from the curbside by playing grounds, and many are set on side streets.

Photo (1) shows El- Nokrashy school buildings

4 Results & Discussion

4.1 Outdoor Noise Measurements

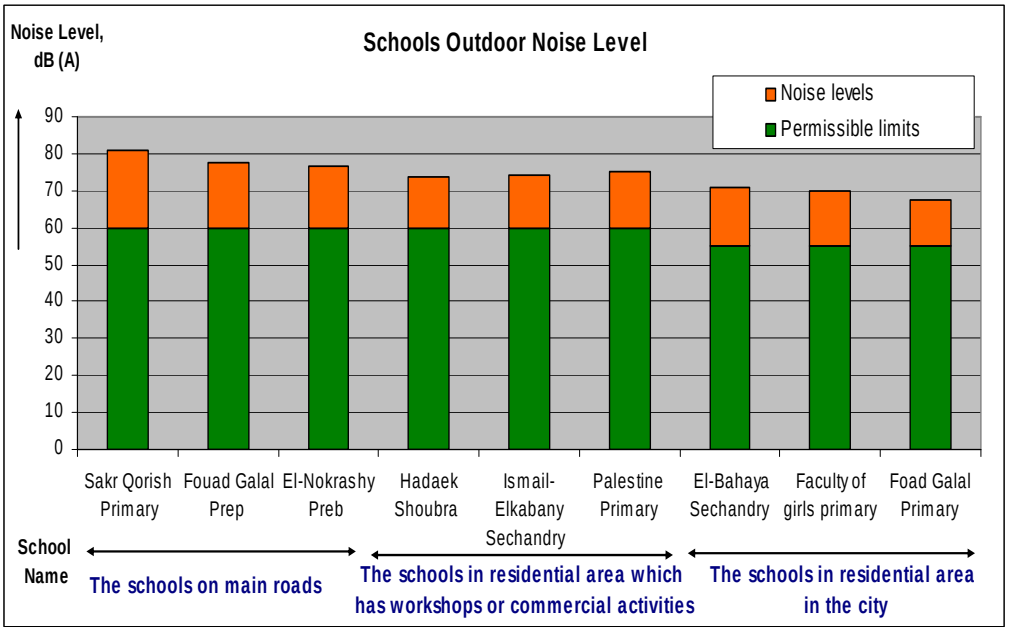

Fig 1: Monthly Average of outdoor Noise Levels for different schools the day periods

In Fig 1, show the monthly average of outdoor noise levels for different schools during March 2009, these schools located in different areas, some of them located on main roads and others located in residential area which has some workshops and commercial activities and also there are some of these schools located in residential area which has low traffic movement and less of the other activities.

The measurement shows that all these schools suffered from the outdoor noise sources, where the average monthly outdoor noise levels for the major of schools exceeded the permissible Limits by approximately (13-18) dB (A) in the day period. And in some schools, such as Sakr Qorish Primary school, the outdoor noise exceeded the permissible limit by more than 20 dB; this is due to the location of this school near a highway with heavy traffic of all types of vehicles including heavy trucks.

4.2 Indoor Noise Measurements

Name of School	The age of Building	Description of School Location	Average Noise level in classrooms (dB)		
			LAeq	Lmax	Lmin
Sakr Qorish Primary school	Modern Building	On main roads	60.3	74.35	55.5
Fouad Galal Prep school	Modern Building		60.15	73.4	53.4
El-Nokrashy Prep School	Modern Building		60.5	71.8	54.2
Hadaek Shoubra Prep School	Modern Building	In residential areas with some workshops commercial activities	61.8	74.15	54.15
Ismail-Elkabani Secondary School	Old Building		59.7	72.5	52.8
Philistine Primary School	Modern Building		58.3	72	49.65
El-Bahaya Secondary school	Old Building	In residential areas in the City	55.4	67.4	46.05
Faculty of girls primary school	Old Building		54.8	65.4	43.3
Foad Galal Primary school	Modern Building		53.9	64.7	47.4

Table 2: Average indoor noise for different schools

Table (2) shows, the indoor measurements in 9 schools where the noise levels LAeq ranges from (54-62) dB; i.e. there are about (19-27) dB above the level of the 35 dB (A) recommended by WHO guideline.

The survey has shown that the presence of pupils even when they are silent leads to increasing of the noise level in the classroom.

4. 2.1 Effect of age of School buildings in the interior noise

The survey was for 9 schools, 6 were for modern building dating from 1975 or Later, the remaining 3 schools were for old buildings which was before 1970, the measurements shows that the indoor noise for the modern school which located in residential area (Foad Galal Primary school) is slightly lower than the old schools (Faculty of girls primary school and El-Bahya secondary school). This could be because room volume in old buildings tend to be greater than those in modern buildings, with a corresponding increase in the amount of relative surface area, so that the reverberant sound level may be higher in general in the old schools, However the sample size is too small for definite conclusion regarding the effect of the age of 5 school buildings to be made.

4.2.2 Effect of the classroom location on the interior noise

Location of Class	Noise level (dB)		
	LAeq	Lmax	Lmin
Ground floor	62.5	74.4	48.7
first floor	60	74.1	50.2
Second Floor	57.3	73.4	47.4
Third Floor	55.2	72.9	45.5
Fourth Floor	53	71.5	46.3

Table 3: Indoor Noise levels at different floors in Elnokrashy School
(As an example of schools which located on main roads)

Table (3) shows, the measurements in El-nokrashy school at four levels (ground, first floor, second floor, and third floor) to indicate the effect of classroom location at any floor on the amount of background noise that reaches the classroom from the street and from other activities. The highest noise level (LAeq) was in the ground level classrooms and it was decreased as the floor level of the classroom was higher.

5 Conclusion

The impact of noise on children's health and development in schools is of major public health concern. This could be greatly reduced if noise problems were taken into consideration in the design of the schools.

A survey of noise levels outside 9 schools in Cairo Governorate showed that the average LAeq measured over whole month during the school day was ranged between 73-78 dB; and the schools which is located close to main roads are exposed to high levels of noise from the vehicular traffic from intermittent use of vehicle horns' and from tires during the sudden use of brakes. The interior noise measurements inside the forty five classes in 9 schools of the survey were ranged between 54-62dB and it was found that the noise decreased as the floor level of the classroom was higher.

Photo (1) shows one class in Faculty of Girls schools

6 Recommendation

1. Noise abatement options include construction of a noise barrier, acoustical treatment of the school structure, or a combination of both. Acoustical treatments may include installing insulation and multi-pane windows. If these treatments are undertaken, the windows must also be sealed to prevent their being opened, which would render the improvements ineffective. Preliminary investigation should be made to determine which method of attenuation is the most appropriate [13].
2. The necessity of land Use planning to put the schools and the educational institutions in the sensitive areas which require lower levels of Noise.
3. Preparing environmental impact assessment studies for the educational institutions projects and the consideration of engineering measures for insulations.
4. Strengthening the implementation of noise regulations included in the traffic law and placing guiding signboards to define sensitive areas to noise.
5. Raise the environmental awareness about the negative effects of noise on the performance of schools and on the public health to prevent the constructions of school buildings in areas with high noise levels which acoustically are not suitable.
6. Development of the codes for the noise levels acceptable to the school building sites, and that the owner and the designer have to be obliged to follow this code; also the stakeholders and the public have to verify the implementations of these values.

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