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Full Length Research Paper

Indoor Noise Pollution in Elementary Schools of Eastern Province, Saudi Arabia

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ABSTRACT

Noise inside schools can be considered as important physical and psychological stressors which may play critical role in students' health, behaviours and performance. In this study indoor noise levels were investigated at stratified proportionate samples of 36 out of a total of 70 schools, randomly selected from governmental and rented schools in Eastern Province, Saudi Arabia. In total 144 classrooms were visited and mean noise levels in each school were calculated. Results revealed that the mean indoor noise level at early morning (8:00 am) in rental and governmental school's classrooms were (mean ± SD) 68.54 ± 8.15 dB and 73.81 ± 9.09 dB, respectively. On the other hand, the mean indoor noise level in the second period (11:00 am) in rental and governmental school buildings were 72.88 ± 7.5 dB and 74.97± 10.1 dB, respectively. The study indicated that there are high levels of noise in classrooms at the visited schools and the average noise levels were found to be significantly higher than the WHO guideline (35 dB). These findings can have important implications for both health and school policies. Research and future studies should be conducted in different schools regarding broader aspects of indoor physical environment and potential hazards.

Keywords: Public Health, Health Promotion, School Health, Education Environment, Noise and Environmental Health

INTRODUCTION

Environmental challenges and opportunities vary considerably among schools around the world, across countries and within communities (WHO, 2004). Nowadays, children experience a key part of their childhood in their school and it forms one of their principal social activities and setting. The Ottawa Charter for Health Promotion stated that “health is created and lived by people within the settings of their everyday life; where they learn, work, play and live” (WHO, 1987).

Indeed, suitable schools provide a social and physical environment that fosters appropriate behavior and facilitate learning. WHO defines a health-promoting school as “one that constantly strengthens its capacity as a healthy setting for living, learning and working” (WHO, 2014). The American Academy of Pediatrics defines a “healthful school environment” as “one that protects students and staff against immediate injury or disease and promotes prevention activities and attitudes against known risk factors that might lead to future disease or disability” (American Academy of Pediatrics, 1993). Therefore, the school environment encompasses the social, physical and biological factors. Moreover, as learning in classrooms is mainly facilitated through verbal and auditory communication between teachers and students (Flexer and Long, 2003), good quality school buildings are required. Students'perception of the school environment, either indoors or outdoors, is directly related to their satisfaction with those environments, and student satisfaction promotes more active behavior (Fjortoft and Sageie, 2000; Herrington and Studtmann, 1998).

Noise pollution can be seen as an endemic part of our modern urban and industrial world. Noise, is an important physical environmental factor plays a critical role in student health and academic performance. It has been

stated that high level of noise can cause irritation, encourage aggressiveness, reduce physical and mental performance, and cause discomfort (WHO, 1990). It has been found that noise has a detrimental effect on children attention (Sanz et al., 1993; Romero and Lliso, 1995). Moreover, the hearing and understanding of speech by children of different ages in various noise and acoustic conditions is a related important research field (Shield and Dockrell, 2003). It is generally accepted that noise has a detrimental effect upon the learning and attainments of primary school children (Berglund and Lindvall, 1995).

Noise control in school environment is a real public health challenge. However, there has been a great deal of research in the past 30 years into the effects of noise on children's learning and performance at school (Shield and Dockrell, 2003), noise pollution studies are still lacking in Saudi Arabia. There is no evidence that studies regarding noise level at schools has been conducted to date that includes a large schools number from Eastern Province, Saudi Arabia. Therefore, the main purpose of this research was to assess the average indoor noise levels in a representative sample of primary school's classrooms in the Eastern Province of Saudi Arabia. Moreover, special concern has been given to compare the mean level of noise between governmental and rented schools.

METHODS

A stratified sampling technique was used to select 36 out of 70 governmental primary schools randomlyselected from the study area. Four classes were chosen randomly from each school for measurements of noise levels allowing for a total of 144 classrooms. Selected primaryschools were classified into two main categories namely; governmental buildings (N = 30), (built by government) and, rental buildings (N = 6), (usually rented houses used as schools).

Measurements were conducted over a period of 10 weeks (March - May, 2012). Data were collected during normal teaching activities. Sampling of noise was conducted at two time intervals (8:00 Am and 11:00 Am). Because of the usual atmosphere (high humidity and temperature), all classrooms which were visited were using mechanical ventilation and have a single wall and have more than one window and windows can be opened manually. All the visited schools were built before 2007 and are located in urban areas in the eastern province of Saudi Arabia.

All measurements were conducted in occupant classrooms during normal occupied academic activities.

Indoor noise levels in classrooms were assessed using calibrated sound pressure level meter (TES 1352A). The collected data were subjected to statistical analysis and presented graphically using SPSS software. Descriptive statistics and independent t-test analysis were also performed. The differences were considered significant at $p< 0.05$.

RESULTS

Descriptive information of the mean noise level in selected schools at 8:00 Am and 11:00 Am intervals are presented in Figure 1.

The mean noise level at early morning (8:00 Am) in rental and governmental schools children were (mean ± SD) 68.54 ± 8.15 db and 73.81 db ± 9.09, respectively. On the other hand, the noise level in the second period (11:00 Am) in rental and governmental school buildings were 72.88 db ± 7.5 and 74.97± 10.1 db, respectively.

Table 1 shows the comparison of mean noise level at different time (8:00 Am and 11:00 Am) in both type of schools. The data shows that noise level increased in both type of schools. However, there were no significant differences between noise levels in classrooms in both rental and governmental schools at both period in the early morning 8:00 AM and at 11:00 AM.

Results presented in Table 2, shows that the mean noise levels in governmental classrooms buildings were slightly higher than the rental type with moderate statistical difference at the early morning period ($p \leq 0.05$), while there no significance differences was recorded at the morning (11.00 Am), ($p> 0.05$).

DISCUSSION

A safe and healthy school environment is crucial for students' health as well as for effective and fruitful education. In the present study, it is clear that level of noise largely exceeds the WHO standard value of 35 Decibel (dB) in governmental schools and rental schools buildings at different periods (Figure 1). In fact, WHO guidelines for maximum noise levels in classroom is 35db and 55 db in outdoor playground (WHO, 1999). Similarly, noise was measured in classrooms of a stratified random sample of 20 schools in Jeddah, Saudi Arabia. The mean level was found to be 60-89 dB and highly exceed the recommended level (Noweir and Ikhwan, 1994). Moreover, results presented in this study are in concordance with the results obtained from other similar studies worldwide. In the review by Picard and Bradley occupied levels in a full range of classrooms from kindergarten to university varied from 42 to 94 dB (Picard and Bradley, 2001). Measurement surveys of classrooms show that classroom noise levels can be high, particularly in classrooms without acoustic treatment, and that this is often due to the noise of classroom activity (Shield and

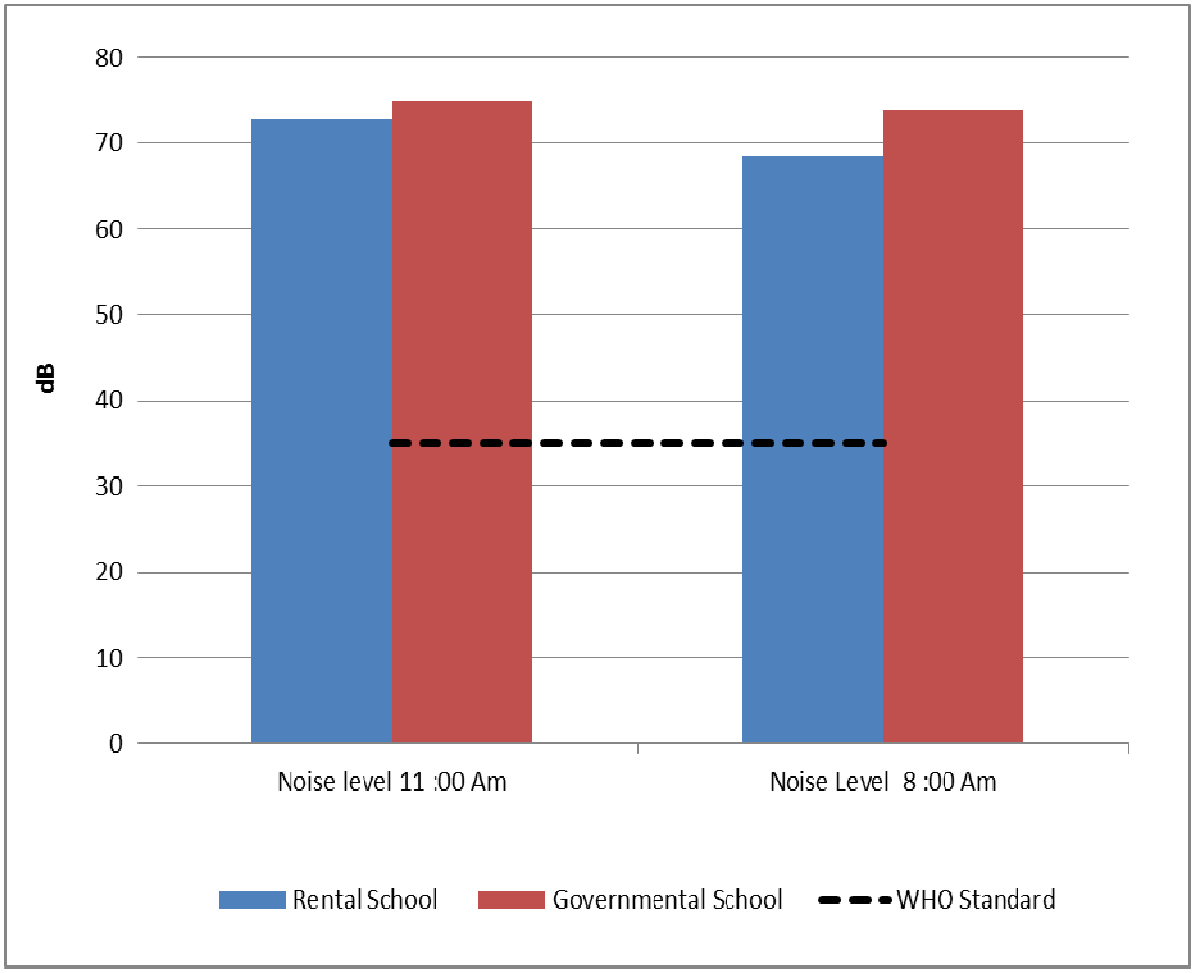

Figure 1. Indoor noise levels in selected rental and governmental primary schools.

Table 1. Mean levels of indoor noise pollution at different time in rental and governmental schools

Type of School	Noise at 8:00 AM Mean ± SD	Noise at 11 AM Mean ± SD	P-Value
Governmental schools	73.81 ± 9.09	74.97 ± 10.13	0.430
Rental schools	68.54 ± 8.15	72.88 ± 7.5	0.162

Table 2. Mean levels of indoor noise pollution between governmental and rental primary schools at different periods

	Governmental Mean ± SD	Rental Mean ± SD	P-Value
Noise (dB) 8 AM	73.81 ± 9.09	68.54 ± 8.15	0.041
Noise (dB) 11 AM	74.97 ± 10.13	72.88 ± 7.5	0.739

Dockrell, 2003).

Significant differences of the mean noise level were observed at 8:00 AM between rental buildings and governmental school buildings (Table 2). That might be explained by the indirect effect of outdoor traffic noise pollution, since the majority of governmental schools are located close to highways and main streets. However, it was reported that high traffic noise levels made a significant contribution to the noise levels of classrooms (Avsar and Gonullu, 2000; Uskun et al., 2007). External

noise is likely to consist of a range of environmental noise including noise from transportation sources, industrial noise and the noise of people outside the school (Shield and Dockrell, 2003). However, the predominant external noise source, particularly in urban areas, is likely to be road traffic (Shield and Dockrell, 2002).

In addition to external noise transmitted through the building facade to a classroom, noise inside a classroom may include noise from teaching equipment (computers, projectors and so on), noise from building services in the classroom, and noise transmitted through the walls, floor and ceiling from other parts of the school (Shield and Dockrell, 2003). In a survey of 140 primary school classrooms, it has been found that the dominant source of noise in a primary school classroom is the noise generated by the pupils themselves as they take part in a range of classroom activities (Shield et al., 2002, Shield and Dockrell, 2004).

Indeed, Hetu and his colleagues found a significant drop in children's performance, particularly in learning to read, when the background noise level interfered with speech (Hetu et al., 1990). Mackenzie in his research compared the performance of children in primary school classrooms that had been acoustically treated, thereby reducing background noise levels and reverberation times, with children in untreated classrooms. 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 (Mackenzie, 2000). According to these, noise level at schools should be considered as a priority in any learning institution.

There are some limitations in the presented study that need to be identified. The noise levels were measured when both teachers and students were in their classes and relatively quiet. Further studies measuring noise level in classrooms during break times and the unoccupied of classrooms would enable results to be directly compared with the recommended levels. Through comparing the unoccupied and occupied noise levels, noise sources can be determined whether is due to external noise, internal noise or to noise generated within the classrooms. Another limitation is that schools and classrooms size as well as students numbers in classwere not investigated which might have an association with indoor noise levels.

CONCLUSION

Noise level measurements were performed at 144 in 36 school complexes in Eastern Province, Saudi Arabia. From the findings of the present study we can conclude that indoor noise levels in the primary schools in Eastern Province were found to be significantly pollutant since it exceeded the WHO guideline (35 dB). From the data of this study several recommendations are generated. Primarily, schools staff should adjust the adolescents' number to the classroom area to overcome the crowding that affect indoor noise and learning. Student's numbers in class and total classroom area should be compatible. Noise levels at classrooms have been found proportional to the number of children (Shield and Dockrell, 2004; Skarlatos and Manatakis, 2003). Schools should be designed to minimize indoor noise at standard level. In general, schools should be constructed a way from high noise area. Moreover, suitable ventilation system and maintenance should be applied, since it has been notice that air-conditions are largely used and is a significant contributor to the noise levels inside the classrooms in visited schools in this study. Failure to deal adequately with noise pollution may go unnoticed, but can and often does take its toll on health, comfort, and performance of teachers and students in school (EPA, 2003).

The study indicated that quantifying air pollution parameters as indoor noise pollution can be an important guide to educationists, health professionals, and community, as well as for policy makers. Policy decision makers should be aware of the results of this study. However, there is a great concern for further research that could be conducted for assessment of other indoor environmental hazards which might affect students and staff health and performance, as well as educational process.

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