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Risk Assessment and Coping Mechanism to Noise in Selected Public Secondary Schools in Ibadan, Nigeria

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Abstract
The deleterious effect of noise on health and learning has been established. Studies reveal that noise interferes in complex task performance, modifies social behaviour and causes annoyance. This study tries to study the effect and coping mechanism to noise of children in selected public secondary schools in Ibadan. The study was descriptive cross-sectional design. Four schools were selected for the study, with three from noisy high activity areas and one from a low noise zone which was used as the control. Three hundred questionnaires were administered, 150 in the control and 50 per noise exposed school., to assess the effect and the children's coping mechanism to noise in the school environment. Noise levels (A-weighted decibels, dBA) were measured with a calibrated sound level meter. The observed noise levels were compared with WHO limits. A Global Positioning System was used to determine the positions of the noise readings used to develop a noise assessment risk map for all the schools under the study. Observational checklist was used to assess noise control parameters and building physical attributes of the schools. The respondents affected by noise reported reading of lips as their coping mechanism to disturbing and loud noise. The Short-term, cross-sectional school-day noise levels in the exposed (65.4 dBA-82.1 dBA) and control (58.5 dBA-71.3 dBA) groups exceeded the WHO recommended limits for school environments (35 dBA). Secondary school occupants in Ibadan, Nigeria are at potential risk of the adverse effect of environmental noise. Adaptation to long-term noise exposure in Nigerian schools is of public health importance as it affects cognitive and learning performances of students adversely.

Introduction

Noise is known to have both psychological and physiological impact that impairs health.

The response to noise may depend on the characteristics of the sound, including intensity, frequency, complexity of sound and duration (Haines *et al.*, 2001 Stansfeld *et al.* 2005). Studies have consistently found evidence that exposure to chronic environmental noise causes annoyance in children, even in young adults (Anomohanran *et al.,* 2004).Wokocha (2013), in a study on the effect of industrial

noise in schools found out that the noise caused and aggravated hypertension, caused chronic headaches, stress and fatigues. The students were also prone to hearing impairment; forgetfulness and also the noise interrupted communication of industrial workers and school children/teachers. In London, child-adapted, standard self-report questions (Fields, 1997) were used to assess annoyance and showed higher annoyance levels in noise-exposed children. In a follow-up one year later, the same result was found, suggesting that annoyance effects are not subject to habituation.

Humans are not usually passive recipients of noise exposure and can develop coping strategies to reduce the impact of noise exposure. If people do not like noise, they may take action to avoid it by moving away from noisy environments or, if they are unable to move away, by developing coping strategies (Haines *et al.,* 2003). Active coping with noise may be sufficient to mitigate any ill-effects. Perception of control over the noise source may reduce the threat of noise and the belief that it can be harmful. It may also be that noise is more harmful to health in situations where several stressors interact and the overall burden may lead to chronic sympathetic arousal or states of helplessness.

The world health organization, recommended 35 dB as the maximum background noise for school environments (WHO, 2000).Study conducted on people exposed to chronic noise from major airports, seem to tolerate it (Evans et al., 1998). Yet, questionnaire studies suggest that high levels of annoyance do not decline over time. Another possibility is that adaptation to noise is only achieved with a cost to health. Evans and Johnson (Evans *et al.,* 1991) found that maintaining task performance in noisy offices was associated with additional physiological effort and hormonal response. In Nigeria, the gap in knowledge about the adverse effect of noise on health has encouraged poor building codes and urban planning implementations. Hence, most of the schools in Ibadan are poorly located with a great majority along main roads. There are few or poorly enforced noise–pollution control laws in many parts of the country.

In developing countries like Nigeria, many children do not have access to ideal or serene learning environments. Noise control in the school environment is hence, a real public health challenge that calls for concern as a considerable proportion of information needed by people today relies on hearing via the telephone, radio and television. Children represent a group which is particularly vulnerable to the adverse health effects of noise. They have less cognitive capacity to understand and anticipate stressors and lack well-developed coping strategies (WHO, 2001). Moreover, in view of the fact that children are still developing both physically and cognitively, there is a possible risk that exposure to an environmental stressor such as noise may have irreversible negative consequences for this group.

This study aimed to provide information on the perceived effects of noise pollution on students in selected secondary schools in Ibadan based on the level and frequency of noise the students were exposed to. Noise levels identified beyond threshold limits would be identified as potential sources for inducing hearing impairment and used to develop a noise risk map. Furthermore, the information gathered in this research would elicit better awareness on the health effect of noise among the school authorities, the students and the general public. This would further assist policy makers and all the stakeholders to know the intensity of the problem and the need for greater attention and enforcement of law regarding noise control.

Materials and Methods

Study Area

The study was carried out in Ibadan North and Ibadan South west L.G.As, Oyo state. Ibadan, the capital of Oyo state is the largest city in West Africa. It is located in south-western Nigeria, 78km inland from Lagos and is a prominent transit point between the coastal region and the areas to the north. It lies between latitude 7° and 9°30' east of prime meridian. Ibadan covers a land area of 12 kilometers radius. It has an altitude generally ranging from 152 to 213m

with isolated ridges and peaks rising to 274m (FEPA, 1998). Its population is estimated to be about 3.8million according to the National Population Commission's (NPC) 2006 census estimates. It is reputed to be the largest indigenous city in Africa, south of the Sahara. The principal inhabitants of the city are the Yorubas. Ibadan has over 300 schools made up of both public and private nursery, primary and secondary schools.

Study Design

The study was conducted in 4 schools which were selected purposively from clusters of high activity areas. The schools used includes: Methodist Grammar School (MGS), Bodija (Market area), Anglican Grammar school (AGS), Total Garden (Traffic area) and Oke-Bola Comprehensive High school (OBCHS), Oke-Bola (Industrial area). Abadina College (AC) located within the University of Ibadan (Academic area), a perceived comparatively low noise zone was used as the control.

The study design was a descriptive cross-sectional survey of environmental conditions of schools using a check list, questionnaire administration to determine students' coping mechanisms to noise in their learning environments and a calibrated nose level meter to measure the noise levels in all the schools.

Study Population

The study population included all students above 14 years of age attending the schools of interest. Using a systematic random sampling technique, 300 respondents were proportionately allocated among the senior secondary classes of the studied schools. The populations among the schools in the experimental group were relatively similar thus the same allocation of 50 respondents were selected per school. The reference group was allocated 150 respondents who were also proportionately selected using a sampling fraction from the senior secondary classes. The participants from each school consented voluntarily and met the eligibility criteria used for the study.

Study Methods

The study methods were grouped into survey, field sampling and statistical methods. A well structured questionnaires and observational check list were used in extrapolating data relating to students' coping mechanism to noise and noise levels in the schooling environments respectively.

Survey Method

The Questionnaires consisted of both open and closed ended questions. It contained information on socio-demographic information, school information, experiences and coping mechanisms related to noise pollution and health conditions. Signed informed consent was received from each respondent having read through and understood the purpose of the study. Participation was voluntarily and the information provided was kept strictly confidential. Pre-test was carried out to ascertain the effectiveness of the questionnaire. Other survey instruments used include an observational check list and an in-depth interview for the school principals.

Environmental Field Sampling Method

The noise levels (all data not reported in this study) were measured using the TECPEL Sound Level Meter (SLM) Model 330 series which was set at the slow mode. The Noise levels were measured in the classrooms close to the head region of the students (while they maintained sitting and standing postures), the corridors, playground and gate area near the noise source (about 10m from the school). For each of the selected schools, four measurements were taken for a period of 20-30 seconds each (Peterson, 1981) at three different periods within one month (within school working hours and days).

A hand-held, battery-powered factory calibrated global positioning system (GPS) was used to determine the geographic coordinates of the school locations and noise measurements. Traffic density, or the manual count of the number of vehicles (automobiles, vans, and

smaller and larger trucks and buses), around the school in the traffic area was also determined during the study period. The classroom dimensions (floor space and the sizes of potentially open doors and windows) were also determined because outdoor sources of air and noise pollution are well-known to impact indoor environments in urban and rural areas worldwide.

In-Depth Interview

In-depth interview was carried out with principals of the four studied schools. An average of 15 minutes was used for each interview. Before the commencement of each session, participants were given full disclosure of the nature of the study and confidentiality of information to be provided was ensured. Permission to use a tape recorder was obtained.

Observational Check List

Observational check list was used to authenticate the response given by the respondents. Indicators observed were; External features of the school premises, internal features of the school building, noise control facilities and distance of the noise sources from the schools.

Statistical Analysis

Data on the completed questionnaires were analysed using descriptive statistics, ANOVA and Chi-square test with SPSS 15.0 statistical package.

Results

General features of the studied schools

All the studied schools in the experimental group were located close to peculiar sources of noise which the students were exposed to in degrees relative to the different activities and the individual proximities of the noise sources to the schools. The control area (AC-University of Ibadan) provided a serene environment being a place of reduced activity because of its academic characteristic. Although there were features like church, mosque, car park, residential quarters, canteen, maintenance unit and hotel inside the university community, these features were located far away from the school area. The general information obtained from the selected schools indicates that all the schools were mixed (males and females). AGS had the highest student population (Table 1). The least average window size was at AC. The smallest average playground size was at OBCHS (Table 2). From the GPS readings the school with the highest elevation was MGS (Table 3). Results from observation checklist revealed that the buildings of most of the schools studied were old and dilapidated as at the time of study. Walls and floor cracks were visible. Most classes lacked ceilings thus increasing the student's exposure to heat, radiation, noise and their associated impacts. Furthermore the classrooms were basically overcrowded (50-60students per class) with only one entrance in most classes. The classrooms were usually rowdy, noisy and un-conducive for learning.

Table 1: General Information about the Schools Studied

Name of school	AC	OBCHS	MGS	AGS
Year established	1977	1979	1978	1977
Number of students	1318	1187	1265	1333
Number of teaching staff	66	45	50	64
Number of non teaching staff	32	20	25	28
Total population	1416	1252	1340	1425
Average number of students per class	50	50	55	60
School category	Mixed	Mixed	Mixed	Mixed
Type of school	Government	Government	Government	Government
Average number of arms	6	5	5	5
Major source of noise	Nil	Industry	Market	Main road
School location	University of Ibadan	NTC Road-Oke Bola	Bodija-Secretariat road	Total Garden

Table 2: Average Area and Dimensions of the Schools under Study

School	Window(m)	Door (m)	Class (m)	Playground/ (m)	Distance from Gate to noise source (m)
AC	1.31x1.22 (*5)	2.2x0.77 (*1)	9.17x8.00	157.3x53.3	---
OBCHS	2.74x1.26 (*3)	2.0x0.82 (*1)	11.91x11.71	46.9x33.42	10.53
MGS	2.4x1.16 (*6)	2.1x0.99 (*1)	7.0x6.93	75.0x40.6	10.20
AGS	2.2x1.14 (*6)	2.0x0.8 (*2)	10.2x15.57	50.0x43.2	11.7

Key: * = Number of window or door per class; m = Meters
Results obtained are the mean values of a window, door classroom or playground. Distance of noise source from the gate is generally for classes from the gate.

Table 3: GPS Spatial Mapping Data

School	Location	Longitude	Latitude	Altitude
AC (Control)	Corridor	N07.45511º	E003.90164º	211m
	Playground	N07.45507º	E003.90181º	204m
	Gate	N07.45423º	E003.90158º	206m
OBCHS	Corridor	N07.37717º	E0033.87759º	210m
	Playground	N07.37721º	E003.87737º	203m
	Gate	N07.37787º	E003.87720º	208m
MGS	Corridor	N07.42929º	E003.91303º	239m
	Playground	N07.42912º	E003.91293º	238m
	Gate	N07.42918º	E003.91263º	248m
AGS	Corridor	N07.39879º	E003.90782º	227m
	Playground	N07.39872º	E0003.90800º	220m
	Gate	N07.39837º	E003.90823º	218m

Table 4: Mean Traffic Density during Five School Days per Month at AGS (Traffic area)

	Day1		Day2		Day3		Day 4		Day 5		Grand Mean	
Time	**Cars**	**Bikes**	**Cars**	**Bikes**	**Cars**	**Bikes**	**Cars**	**Bikes**	**Cars**	**Bikes**	**Cars**	**Bikes**
7-8am	884	776	887	718	886	697	880	761	802	736	**868**	**738**
8-9am	919	744	953	765	928	758	938	734	967	768	**941**	**754**
9-10am	988	756	943	717	892	702	974	710	854	677	**930**	**712**
10-11am	818	763	918	727	889	731	862	730	794	712	**856**	**733**
11-12noon	921	746	912	736	882	723	841	764	813	755	**874**	**745**
12-1pm	859	813	845	715	849	723	860	771	812	750	**845**	**756**
1-2pm	936	819	904	755	939	769	942	758	898	696	**924**	**759**
Total	**6325**	**5416**	**6362**	**5133**	**6266**	**5104**	**6298**	**5228**	**5940**	**5094**	**6238**	**5197**

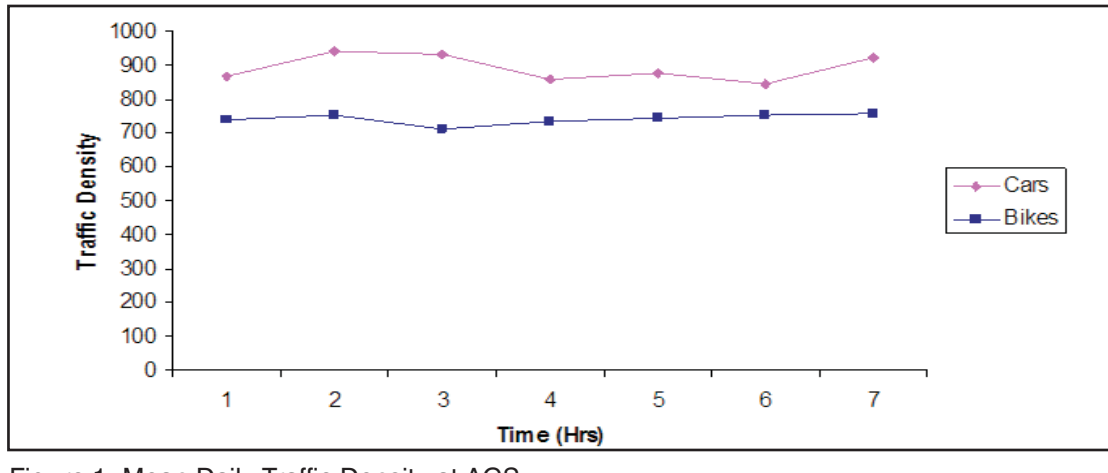

Figure 1: Mean Daily Traffic Density at AGS

Key:
1= 7am-8am 5= 11am-12noon
2= 8am-9am 6= 12noon-1pm
3= 9am-10am 7= 1pm-2pm
4= 10am-11am AGS= Anglican Grammar School

Traffic Density Measurement at Anglican Grammar School (AGS)

The traffic density at Queen Elizabeth's Road, being the main source of environmental noise around AGS was determined. The observation showed that the number of motor cars were more than motor bikes generally. The mean average number of vehicles that plied the road within the study period per day was 6238 vehicles and a mean total of 5197 for motor bikes. The highest frequency of cars was recorded between 8-9 am in the morning and between 1-2 pm in the afternoon for bikes (Table 4, Fig 1)

Survey Results

Socio demographic Characteristics of Respondents

A total of 300 copies of questionnaires were administered to the study population comprising 150 respondents from the exposed group (50 participants per school) and 150 from the control group. All the respondents were drawn from the senior secondary (SS) classes. With this population, a 100% participatory rate was achieved There was no significant difference in age between the exposed and the control group. The study population was a total of 167(55.7%) females and 133(44.3%) males whose age ranges from 15-19years with a mean age of 15.6±0.7 years.

Noise Levels in Studied Schools

The range of noise levels in the exposed (65.4 dBA-82.1 dBA) and control (58.5 dBA-71.3 dBA) groups exceeded the WHO recommended limits for school environments (35 dBA). The mean noise levels for the specific exposed groups include 73.8±5.1 dBA (AGS), 76.0±8.0 dBA (MGS), and 70.8±8.5 dBA (OBCHS) compared to the control of 63.8±5.3 dBA ($p<0.05$).

Experiences and Coping Mechanisms of respondents to Noise

Most of the respondents (80% OBCHS, 62% AGS and 80% MGS) in the exposed group reported that they often experience loud noise in their school environment. Despite their exposure to noise, only few of the respondents from the exposed group agreed that their academic performances were affected badly with respect to noise. About 22%, 32% and 24% respondents from OBCHS, AGS and MGS respectively reported that their current academic performance was excellent.

Only a few of the respondents from each school in the exposed group agreed that they were aggressive (easily quarrelsome) which had no significant difference when they were compared to the control (10%) ($p>0.05$). These results were similar to the responses obtained for their being aggressive before they started attending the present school under the study which means that the noise in their present school had little effect or no effect on them in this respect. Each response also showed no significant difference when compared to the control (14.7%) ($p>0.05$).

Only 16%, 26% and 30% of respondents from OBCHS, AGS, and MGS, respectively reported that people had to repeat themselves and often shout before they could hear them with 12% agreeing to same from the control.

The act of reading lips which is a coping mechanism and also an attribute of not hearing well was reported by 14% of respondents from MGS with 34% doing it sometimes while the control showed 2.7% of the respondents were used to reading lips while 14% were doing it sometimes ($p<0.05$). More information on other experiences and coping mechanism with respect to noise are represented in Table 5.

Noise Risk Map

The mean noise levels recorded from the exposure group and the control alike were all found to exceed the WHO guide line limits of 35dBA for school learning environment. Based on the results obtained, the Risk map developed

Table 5: Experiences and Coping Mechanisms of Exposed Group and the Control Related to Noise

		Schools N(%)			
		Exposure Group			Control
Variable	**Options**	**OBCHS**	**AGS**	**MGS**	**AC**
Often experience loud noise in school environment.	Yes	40(80.0)	31(62.0)	40(80)	24(16.0)
	No	10(20.0)	19(38.0)	10(20.0)	126(84.0)
Easily angry and quarrelsome before schooling here	Yes	10(20.0)	11(22.0)	8(16.0)	22(14.7)
	No	40(80.0)	39(78.0)	42(84.0)	128(85.3)
Quarrel easily and frequently now in this school	Yes	8(16.0)	13(26.0)	9(18.0)	15(10.0)
	No	42(84.0)	37(74.0)	41(82.0)	135(90.0)
Have difficulty in hearing teacher clearly	Yes	4(8.0)	5(10.0)	4(8.0)	5(3.3)
	No	19(38.0)	35(70.0)	20(40.0)	111(74.0)
	Sometimes	27(54.0)	10(20.0)	26(52.0)	34(22.7)
People repeat selves and shout before you can hear	Yes	8(16.0)	(26.0)	15(30.0)	18(12.0)
	No	2(84.0)	37(74.0)	35(70.0)	132(88.0)
Have difficulty in picking specific voice in a gathering	Yes	5(10.0)	7(14.0)	6(12.0)	17(11.3)
	No	22(44.0)	25(50.0)	19(38.0)	110(73.3)
	Sometimes	23(46.0)	18(36.0)	25(50.0)	23(15.3)
Find self-reading lips when talked to	Yes	9(18.0)	5(10.0)	7(14.0)	4(2.7)
	No	29(58.0)	28(56.0)	26(52.0)	125(83.3)
	Sometimes	12(24.0)	17(34.0)	17(34.0)	21(14.0)
Present academic abilities	Poor	0(0.0)	0(0.0)	0(0.0)	1(2.0)
	Fair	8(16.0)	5(10.0)	4(8.0)	14(9.3)
	Good	31(62.0)	29(58.0)	34(68.0)	71(47.3)
	Excellent	11(22.0)	16(32.0)	12(24.0)	64(42.7)

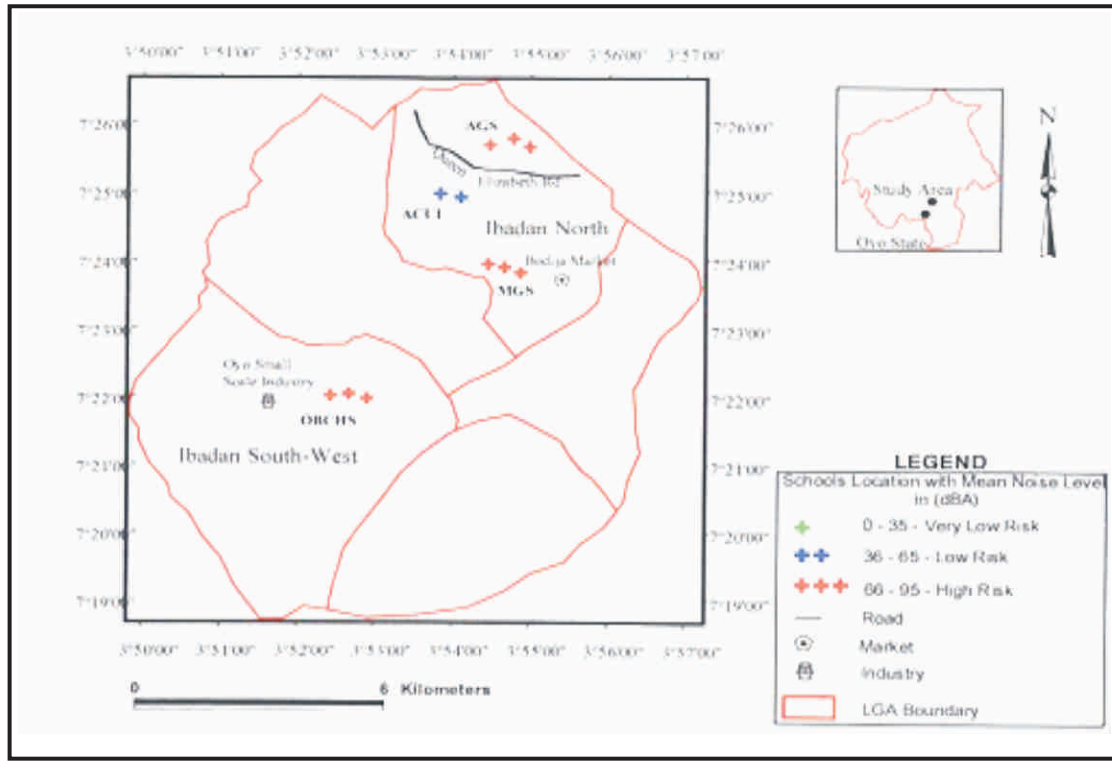

Figure 2: Noise Risk Map for Selected Schools in Ibadan

from the schools showed the actual ground positions of the schools on the map, indicating the schools at low risk (36-65dBA) and high risk (66-95dBA) in relation to their mean noise levels measured. All the schools in the exposed group had noise levels that were classified as under the high risk group. MGS recorded the highest mean noise level of 76 dBA (High risk) while the control (AC), had a mean noise level of 63.8 dBA (Low risk) (Fig 2).

Discussion

The results obtained above could be seen to be highly attributed to the noise in the school environments based on their characteristics: Bodija market is located by the Secretariat-University of Ibadan road. The market is known for its characteristic rowdiness, and irritating noise that constantly pollutes the air as a result of loud chattering by both the buyers and sellers alike, generators and grinding machines. The market is the major market in Ibadan also comprising a car park very close by where conductors engage in frequent shouting of their destinations to attract passengers. Added to this is a busy road adjacent the school gate that generates high noise level as a result of automobiles and the occasional locomotive engines of trains.

Queen Elizabeth road, Total Gardenisa major road adjacent the school gate connecting two very busy areas known as 'total garden' and 'Mokola'. It is characterized by a heavy highway traffic density. The noise generated comes from horn hooting, the engine, exhaust, sirens, motor bikes and faulty equipment like defective mufflers.On the other hand Ibadan small scale industrial layout, former NTC road, Oke-Bolaisa small scale industrial layout as the name implies, provided by the government of Oyo state to help provide indigenous people of the state and foreigners, job opportunities and a means of revenue generation. The industrial area is known to harbor over ten (10) currently functioning small scale industries ranging from saw milling and furniture production, pure water, printing press, canned juice among others. These activities generate loud noise from their machines and generators that power

their production processes hence, affecting the learning environments of schools located close by. All the schools studied were less than 10 metres away from the noise sources.

The University of Ibadan (UI) is an academic community with minimal activity compared to other three locations. It is an institution concerned about learning and research.UI is a serene area with comparatively reduced activity which served as the control area. Though it has features like church, mosque, car park, residential quarters, canteen, maintenance unit and Hotel inside the university community, the residences, campus and schools within are located some distance away (>50metres) from these activity areas. Most of the respondents from the exposed group agreed that they often hear loud noise from their school environment. An appreciable number also agreed that they sometimes have difficulty in picking a specific voice in a gathering, thus found themselves reading lips as a coping mechanism to the adverse effect of noise. This result is in line with the findings of Haines et al., (2003) who reported that school children device coping mechanisms to shut out the effect of noise in their schooling environment like using their hands to block their ears to shut out loud impact noise. The noise levels recorded also shows that the students schooling in schools in Ibadan are exposed to high noise levels that may be capable of inducing hearing impairment. The effects of noise are strongest for those outcomes that, like annoyance, can be classified under 'quality of life' rather than illness. What these effects lack in severity is made up for in numbers of people affected, as these responses are very widespread (Hygge *et al.,* 2002).It may be that the risk of developing mental or psychosocial illness attributable to environmental noise is quite small, although it is too soon to be certain of this in terms of the progress of research. Part of the problem is that the interaction between people, noise and ill-health is a complex one.

Conclusion

The result from this study shows that a good number of schools in Ibadan are faced with noise levels that exceeds the WHO recommended limits hence, presenting a harsh and uncondusive environment for children to learn in. The respondents coping mechanisms to noise in their schooling environment does not show an effective control to the plague of noise. This could be greatly reduced if noise problems were taken into consideration as early as possible when a school is being designed. In summary, children are indeed influenced by the presence of environmental noise. These findings suggest that schools should be located in areas that are as noise-free as possible. Adaptation to long-term noise exposure needs further study.

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