PRINT ISSN 1119-8362
Electronic ISSN 2659-1502

Full-text Available Online at
https://www.ajol.info/index.php/jasem
http://www.bioline.org.br/ja

J. Appl. Sci. Environ. Manage.
Vol. 27 (3) 631-637 March 2023

Indoor Noise Exposure and Related Health Risks in a Tertiary Institution within Edo State, Nigeria

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ABSTRACT: Noise pollution is a problem in many countries around the world. In schools, exposure to noise causes a wide range of adverse effects on the health and performances of students and teachers. This study evaluated indoor noise exposure and related health risks in selected offices, classrooms and laboratories in a tertiary institution within Edo state, Nigeria using a digital sound level meter (Smart Sensor Model AS824). The mean levels of noise in the selected offices, classes and laboratories ranged from 44.1 – 57.9 dB, 52.8- 60.7 9 dB, and 51.1 – 58.4 dB respectively across the Faculty. The mean noise levels all exceeded the WHO and NESREA limits for noise in educational facilities. The level of noise measured in classrooms was significantly higher than those of offices and laboratories in the departments of Computer science (F=4.117; p=0.009), Chemistry (F= 6.41; p = 0.01), and Mathematics (F=3.75; P=0.01). The interactions among students during lectures and operations of office appliances were the most reported sources of high levels of noise in the study area. Stress, fatigue and high blood pressure were mostly identified among students and lecturers as health effects of high noise levels within the Faculty. The planting of trees, installation of sound insulators and awareness creation on the health effects of noise pollution in the institution are strongly recommended.

DOI: **https://dx.doi.org/10.4314/jasem.v27i3.31**

Cite this paper as: EDENE, A. O; EGHOMWANRE, A. F (2023). Indoor Noise Exposure and Related Health Risks in a Tertiary Institution within Edo State, Nigeria. *J. Appl. Sci. Environ. Manage.* 27 (3) 61-637

Dates: Received: 07 February 2023; Revised: 18 March 2023; Accepted: 28 March 2023
Published: 31 March 2023

Keywords: Noise pollution; Sound meter; Educational facilities; Sound insulators; Health risk

People of various age groups spend a large portion of the day and even some parts of the night-time in the school environment. These may include young children, teenagers, young adults and even middle-aged people (Yassin *et al.*, 2016). Various kinds of environmental pollution take place in indoor and outdoor school environments. Among indoor pollution, noise pollution is one of the most prominent issues which affect health and learning in schools (Zannin and Zwirtes, 2009). Noise in the school environment comes from many external or internal sources (Quartey *et al.*, 2021). The external sources often depend on the land-use zone where the school is located. The setting of schools in commercial zones, close to roads with high traffic activity or near industrial areas is one of the major reasons why external noise may be present in the school environment (Silva and Mendes, 2012). Internal noise in schools may be from equipment for learning, building management service equipment, power generating sets, talking, and movement of the students which can reverberate and further exacerbate in confined spaces (Mealings, 2022). Auditory effects of noise exposure have been found to include noise-induced hearing loss which children are highly susceptible to, tinnitus, impairment of cognitive ability, reduction in work performances, auditory fatigue and poor attention span (Tiesler *et al.*, 2013). The non-auditory effects of noise exposure include cardiovascular disorders, sleep disturbances,

annoyance and in some cases, decreased immunity to diseases (Agarwal and Swami, 2011). Noise exposure may have social impacts due to its effects on human health. Hence, appropriate measures to control noise are needed (Chan *et al.,* 2015). In schools, noise pollution may cause discomfort to teachers and students, fatigue, lack of concentration and changes in regulatory responses to stress and may result in a drop in academic performance levels (Quartey *et al.,* 2021). The WHO have established guidelines for environmental and leisure noise exposure due to its potential for several adverse health outcomes (WHO, 2018). The recommendations are targeted at minimising the adverse effects of noise on health (Mealings, 2022). These regulatory limits cover standards for noise from diverse sources such as traffic, railway, aircraft, wind turbine and noise from leisure activities emanating from either indoor or outdoor events including recommendations for external noise such as road traffic noise, railway noise, aircraft noise, and wind turbine noise. The limit for recommendation is based on minimizing negative effects on health and sleep (WHO, 2018). The guidelines established for the above noise sources are mostly based on 24 h period boarding on an external average day, evening and night. However, the impact of noise entering the classrooms on students during school hours would be based on the 5 to 8 h period. The acoustic recommendation for microenvironments within the school premises is 35dB (WHO, 2018) and 45dB (NESREA, 2009). In Nigeria, the continued increase in noise pollution in schools points to the fact that despite the document on permissible noise limits released by NESREA, the lack of political will or legal framework for implementation is still a challenge. The attitude of specialized environmental health officers whose duty is to routinely monitor environmental noise levels and other related environmental hazards is appalling as lots of the officers are non-functional in the school environment. There are several studies on the level of noise in the primary, secondary and higher institutions of learning in Nigeria (Ana *et al*., 2009; Ntui, 2009; Amakom *et al*., 2019; Wekpe and Feberisima, 2020; Oguchuckwu *et al*., 2021). These studies have focused on either classrooms or laboratories and not more than one microenvironment at a time. Hence this study attempts to determine the level of noise in the offices, classrooms and laboratories and its impact on the student's health in a tertiary institution in Benin City, Nigeria.

MATERIALS AND METHODS

Study area: This study was conducted at the Faculty of physical sciences, University of Benin, Benin City, Edo State, Nigeria. The University is geographically located at 6º20'1.32" N and 5º36'0.53" E, within Ovia North-East Local Government Area, which is one of the Local Government Areas that make up Benin City. The University has over 70,000 students in total, spread out over several Faculties including the Faculty of Physical sciences. Sampling was carried out in the offices, classrooms and laboratories of the various departments which make up the faculty. This includes departments of Mathematics (DM), Statistics (DS), Geology (DG), Computer Science (DCS), Chemistry (DC) and Physics (DP). The Faculty of Physical Sciences is situated over an area that stretches from behind the University's main auditorium and is encompassed by nearby roads, event halls and business centres. The classrooms, offices and laboratories are all sited within the school and are characterized by the influx of people including students, and lecturers daily with a lot of activities.

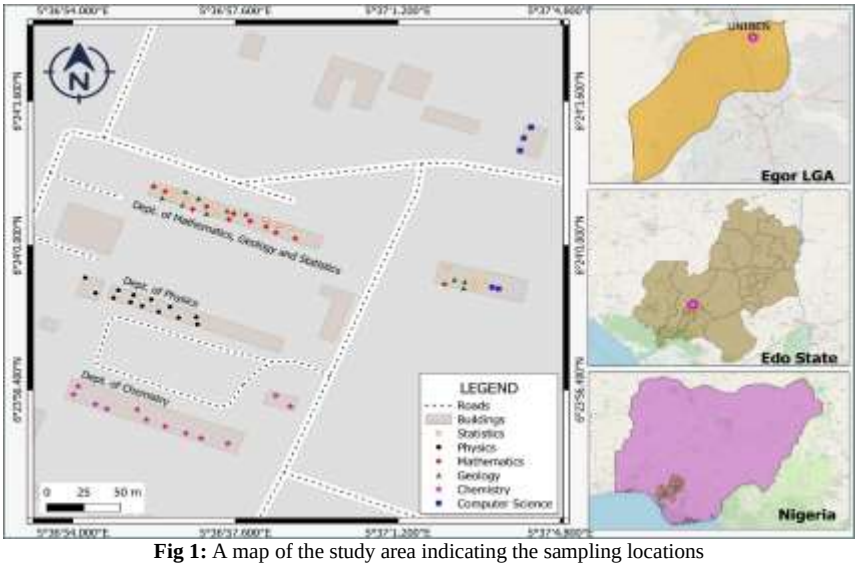

Fig 1: A map of the study area indicating the sampling locations

Sampling locations and Procedure: The locations for sampling during this work were randomly selected across the Faculty. Two classrooms, offices and laboratories were selected for sampling for three months. The readings taken in each department were represented as; DGo, DGc, DGl (Offices, classrooms and laboratories in the Department of Geology); DCSo, DCSc, DCSl (Offices, classrooms and laboratories in the Department of Computer sciences); DCo, DCc, DCl (Offices, classrooms and laboratories in the Department of Chemistry) DMo, DMc, DMl (Offices, classrooms and laboratories in the Department of Mathematics), DSo, DSc, DSl (Offices, classrooms and laboratory in the Department of Statistics) and DPo, DPc, DPl (Offices, classrooms and laboratory in the Department of Physics) during the sampling regime. The measurement of noise levels was done within the period of 8 am when the school opens and 4 pm when the academic activities end. The measurement was performed at 8 hourly intervals as described by Yassin *et al.* (2016), across the selected offices, classrooms and laboratories using a calibrated digital sound level meter (Smart Sensor Model AS824) with an accuracy of +/- 1.5dB. During the measurements, the microphone was facing the four cardinal points and at a height of about 1.5 cm above the ground level for a one- to two-minute period at each sampling point to ensure accurate readings. The readings were taken in triplicates during the study between October and November, 2022. The mean values of data collected during the study, therefore, contained the equivalent noise levels at each point recorded in dB as recommended by the World Health Organisation (WHO, 2018).

Questionnaire survey: A structured questionnaire was developed and divided into sections. Section A consisted of socio-demographic information which includes age, gender, and level of education, while sections B, C and D comprise sources, adverse health effects of noise pollution and students' perceptions of noise in the school environment. The respondents were recruited through random selection across the six departments in the faculty. A total of one hundred and twenty questionnaires (twenty per department) were administered. The purpose of the study was explained to the selected respondents who gave their consent. The interview lasted about 15 to 20 minutes per participant.

Data analysis: The data obtained from the study were analysed using SPSS version 21.0. Descriptive analysis was carried out to obtain the frequency and percentages of the socio-demographic information, sources of noise, health effects and perception of noise pollution obtained from the questionnaire. The measured noise levels were subjected to inferential statistics. Mean and Analysis of Variance - ANOVA were used to obtain the mean noise levels in dB and determine the variations in noise levels across the sampling locations.

RESULTS AND DISCUSSION

Mean Noise levels at the selected offices, classrooms and laboratories: The mean noise level measurements for offices, classrooms and laboratories in the various departments are presented in figure 2a and 2b. In locations DGo, DGc and DGl, the noise level varied between 44.5 – 50.3 dB, 56.1 – 57.1 dB and 52.7 – 56.1 dB respectively. The highest noise level was obtained in the classrooms while the lowest was recorded in the offices. Noise measurement did not vary significantly across the sampling locations (F= 0,865, 1.623, 0.421; P = 0.55, 0.20, 0.88). The noise level at the offices, classrooms and laboratories in DCS varied between 44.1 – 53.5dB, 52.8- 58.6 and 51.1 – 58.4 dB respectively. The noise pollution level was highest in the classrooms compared to the laboratories and offices, the variations were only significant at the DCSo location (F= 4.117; p = 0.009) (Figure 2a). The noise level at DCo, DCc and DCl ranged from 44.4 – 52.7dB, 57.1 – 62.2dB and 49.5 – 56.3 dB respectively. The highest noise level was measured at DCc while the lowest was recorded at DCo. The measurement of noise in the classrooms of the department of Chemistry was significantly higher (F= 6.41; p = 0.01) than the noise levels at the offices and laboratories. At the Mathematics department, the noise level in the classroom (DMc) was also higher compared to those recorded at the DMo and DMl locations. The measured noise level was highest at DSc and DPl with mean values ranging from 50.4 – 50.8 to 56.3 to 60.7 dB (Figure 2b). Generally, the mean noise levels obtained in all the sampling locations were higher than the recommended mean values by the World Health Organization (WHO) and National Environmental Standards Regulation and Enforcement Agency (NESREA) (NESREA, 2009; WHO, 2018). The high noise level above obtained in this study could be attributed to the verbal exchanges, shouting and highly repetitive teaching that takes place in the classrooms, due to a large number of students; especially between Lecturers and students and between the students themselves. Other likely contributory factors could be external sources of noise such as generator noise. This finding is consistent with the reports of Ochiabuto *et al*. (2021) who suggested that the absence of acoustic devices in Nigerian schools could be responsible for the high level of noise pollution in her classrooms. Chan *et al*. (2015) also suggested that external noise could be ameliorated in the classroom by the installation of acoustic

modifications such as double glazing and solid concrete barriers in classrooms. Several studies have also reported high noise levels in classrooms in Nigeria (Bulunuz, (2014); Ebrahim *et al*., (2017).

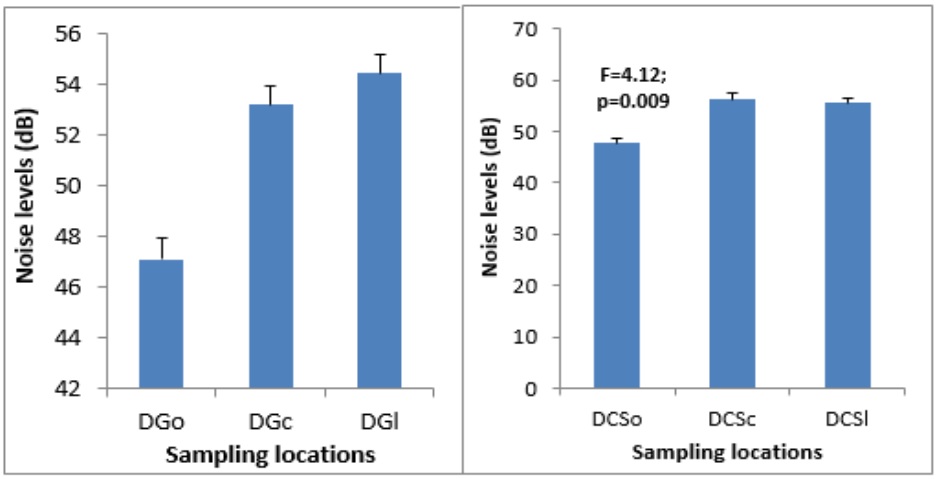

Fig 2(a): Mean Noise levels (dB) across the offices, classrooms and laboratories

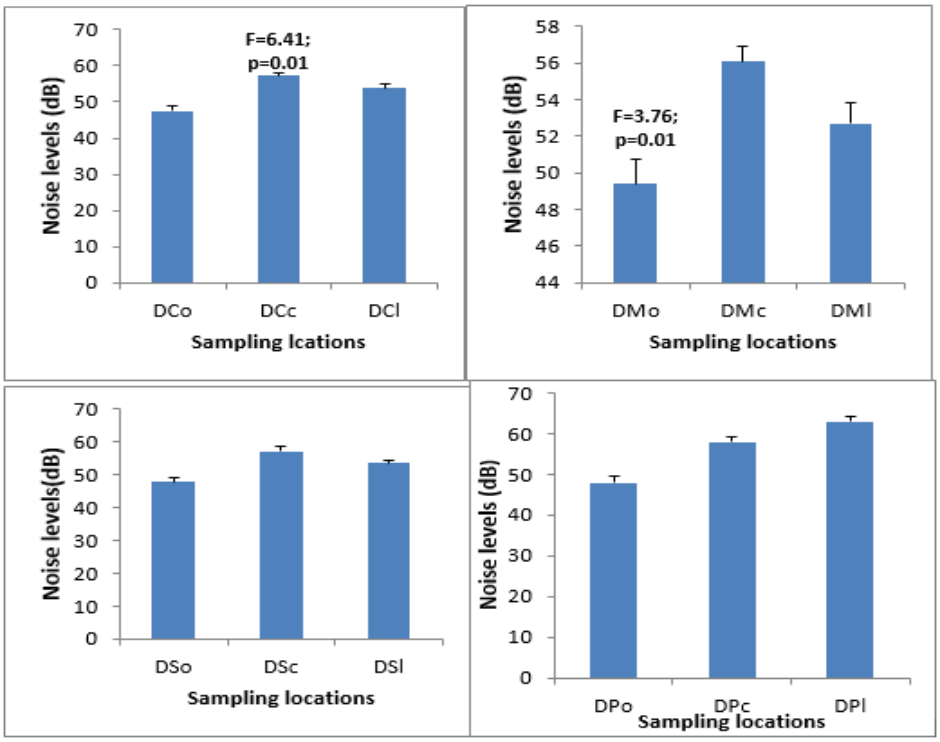

Fig 2(b): Mean Noise levels (dB) across the offices, classrooms and laboratories

The increased level of noise in the offices could be due to noise from office appliances such as air conditioning, fans, and other external sources of noise such as generator noise occasioned by the incessant power failure in the faculty. Teachers may be coerced to raising their voices in loud or reverberant classrooms resulting in stress, fatigue and the risk of teacher voice impairment. The on-site assessment revealed that the offices were generally small hence noise is more sporadic and tends to be intrusive. Noise in the sampled laboratories could be due to the type of equipment such as refrigerators, centrifuges, and stirrer motors which generate steady noise in the laboratories. In most of the laboratories used during this study, a large number of students in groups are permitted into the laboratories during practical classes. Students find it difficult to interact without shouting as a result of the distance of the next students. The exposure to high noise level poses several health risks to the students and teachers in the study area. The

variations found in the level of noise in the classrooms, offices and laboratories could be attributed to the differences in the prevailing environmental factors in the different microenvironments. Khan *et al*. (2021) opined that the emission of noise from different sources varies with microclimatic conditions due to changes in ground absorptivity. Hence high noise levels in classrooms, offices and laboratories may pose demonstrable impacts on students and lecturers. Several studies have reported that fatigue, lower efficiency, increased heart rate, dyspepsia, poor appetite, annoyance, depression, anxiety, insomnia, headache and tinnitus are some of the health risks associated with exposure to high noise levels (Yassin *et al*., 2016; Baafi, 2020; Hao *et al*. 2022).

Percentage Responses from students and teachers: To further help in achieving the study's objectives, information from the social survey is important to assess and evaluate the health issues associated with exposure to high levels of noise. The responses from the survey of this study were expressed in percentages and presented as charts in Figures 3 to 6. The interviewed staff attributed the perceived high noise levels in the offices and laboratories to the working of office appliances such as air-conditioners, ceiling fans, laboratory equipment, exchanges during laboratory practical sessions and movements on walkways. Forty per cent (40%) of the respondents reported that office appliances such as fans and air conditioners contributed to the high level of noise pollution in the offices (figure 3).

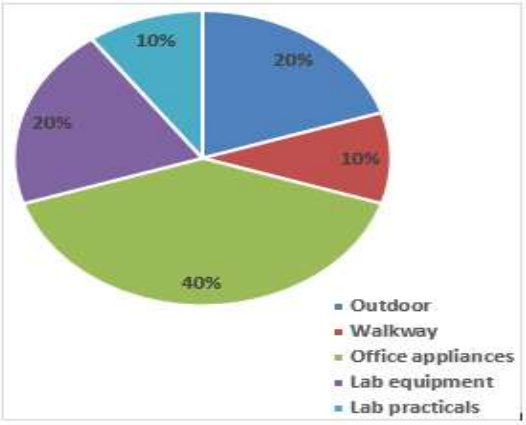

Fig 3: Sources of noise in the Faculty

Majority of the staff reported stress (46%) as the perceived effect of exposure to noise in the study area (figure 4). Other responses were 37% and 13% for fatigue and agitation respectively. The findings are similar to the result of Yassin *et al*. (2016) who found that tiredness and fatigue were mostly reported by teachers from primary, secondary and higher institutions after the school day. Twelve per cent (12%) of the respondents could not trace any particular health effects to levels of noise pollution (figure 4).

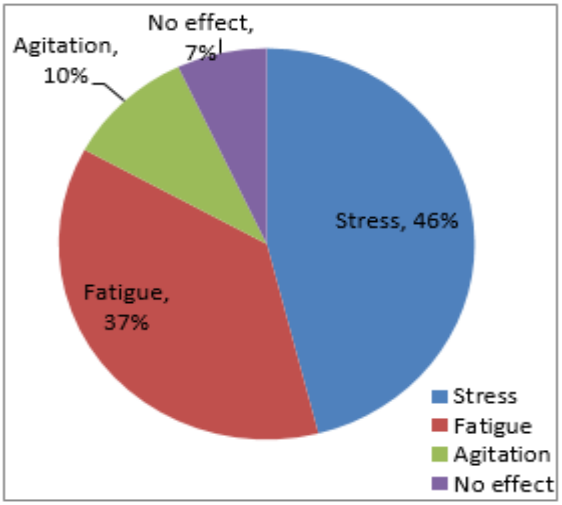

Fig 4: Adverse effects of noise experienced by staff

Furthermore, the perception of the students about the sources of noise in the Faculty was also investigated, The students identified chatting amongst students (38%), vehicular movements (15%), noise from car horns (12%), ceiling fans (15%), voices from persons walking by (8%) use of generators (12%) during classes as major sources of increased noise levels in the study area (figure 5).

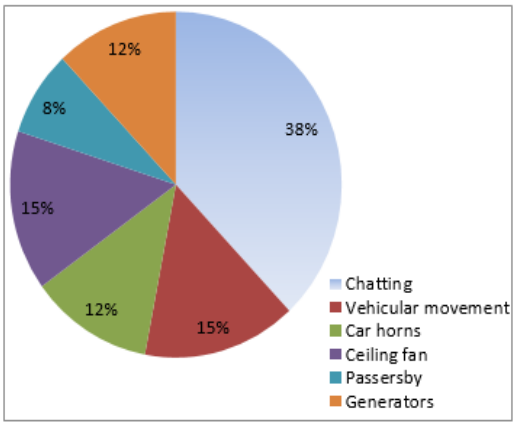

Fig 5: Student's perception of noise sources in the Faculty.

The responses of the students on the associated health impact of the high noise level in the classrooms and laboratories are presented in Figure 6. The majority of the students often suffer from headaches as a result of noise exposure. Stress was also found to be common among students exposed to high noise levels. Other complaints reported included fatigue (20%), hearing defects (5%), high blood pressure (10%) and distractions (15%). This could greatly reduce the

students' level of educational performance (Amakom *et al*., 2015). Similar health conditions as a result of exposure to high noise levels have been reported in several other surveys (Ana *et al*., 2009; Yassin *et al*., 2021; Oguchukwu *et al*., 2021).

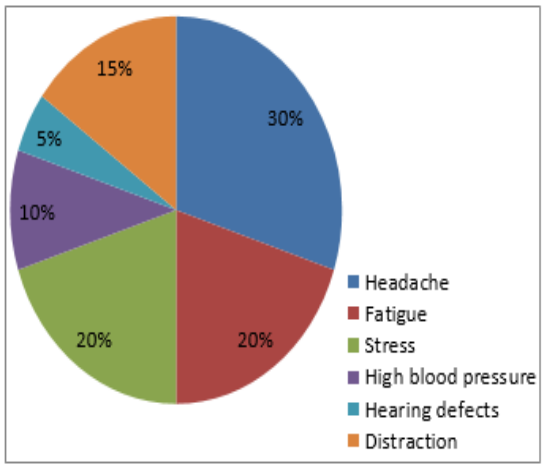

Fig 6: Effects of noise on students

Conclusion: The increased level of noise as seen in this study calls for concern as it could result in low productivity and reduced academic performance among the staff and students of the institution. Further studies on noise exposures in the study area should include measurements of noise levels both indoors and outdoors and across space and seasons. The management of the institution and all educational stakeholders should be involved in policy formulation and implementation to promote enhanced learning and a serene work environment void of excessive noise

Acknowledgement: The authors would like to acknowledge the Dean, staff and students of the Faculty of Physical Sciences, University of Benin for the permission granted and assistance provided during the research.

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