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Noise from Portable Electric Power Generators in an Institutional Setting: A Neglected Risk Factor

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Abstract: An ideal educational setting should be serene and conducive for both learning and working. However, due to the erratic power supply in Nigeria coupled with increase in number of commercial outfits, there has been an upsurge in the proliferation of portable generators at institutional settings. Studies conducted on noise from portable generators and its effects on human health in institutional environment are sparse. Noise levels from exposure to portable generators and its perceived attendant effects was assessed in this study. Oladele Ajose building (OAB) was purposively selected for this pilot study based on the frequency of generator use and level of commercial activities. A semi structured questionnaire was used to elicit information from staff and students. Noise levels in decibels (dB) was measured in six selected location for eight weeks in the indoor and outdoor environment of the building, using a calibrated AEMC sound meter. Results were compared with WHO guideline limits. Mean noise level in the indoor and outdoor environment was 60.26±8.45dB and 58.15±4.53dB respectively. Reported health problems in the last six months prior the study include ear pains (68%), headache (46%), tiredness (60%) and tinnitus (34%). Occupants of OAB are exposed to noise from electric generator at levels exceeding WHO limit. There is a need to find an alternative way to power generation in institutional settings because of the threat noise from generators poses to the serene and conducive learning environment.

Keywords: Noise Levels, Health Effects, Portable Generators, Ibadan

1. Introduction

Noise is progressively becoming ubiquitous, yet an ignored form of pollution in developed and developing countries [1, 2]. Noise pollution is a threat to health and well-being, an environmental stressor and nuisance [3]. It is one of the foremost environmental pollutants that has direct effects on human performance [4]. The continued survival of man is contingent upon the enabling environment where he resides, as disruption in the conducive environment may lead to dysfunction in his health status [5]. Urbanisation, civilisation or industrialisation is majorly characterized with noise pollution. Noise is derived from the Latin word "nausea" implying 'unwanted sound' or 'sound that is loud, unpleasant or unexpected [6].

Electricity, one of the benefits of industrialization has become a major priority for most people as they try to meet their domestic, commercial and industrial needs. The world conventional energy supply in 2004 showed that Africa's highest supply in descending order of magnitude as follows: South Africa-30,020MW; Egypt-14,250MW; Algeria-6,188MW; Libya-4,710 MW; Morocco-3,592MW and Nigeria-3,500MW. But between 2005 and 2009, power generating capacity in Nigeria oscillated between 2,600MW and 3,000MW [7]. According to the Nigerian Energy Policy report from 2003, it is estimated that the Nigeria population connected to the grid system is short of power supply over 60% of the time. In addition, less than 40% of the population is not connected to the grid [8].

The need for electricity in homes, workplaces and industries is high. Yet, the erratic supply of none or low voltage electricity by Power Holding Company in Nigeria makes it

imperative for individuals, companies and factories to generate the needed electricity through portable generators without considering its attendants effects [9, 10]. A portable electric power generator is a gasoline or diesel-powered device that provides temporary electrical power up to certain voltage and designed for outdoor use [11]. Portable generators are used very commonly in shops, offices and homes today in order to supply power during power shutdowns [12]. The use of generators in every household in a country like Nigeria because of erratic power supply creates seemingly unbearable noise [2]. The noise may be generated by aerodynamic effects or due to forces that result from combustion process or may result from mechanical excitation by rotating or reciprocating engine components [13].

Noise is described in terms of loudness (intensity) and pitch (frequency) and noise exposure is measured using a logarithmic decibel (dB) scale [14]. The Occupational Safety and Health Administration (OSHA) recommends hearing protection in the workplace if there is exposure to noise greater than 85 dB for eight hours or more because of the potential of permanent hearing loss. Noise, even at levels that are not harmful to hearing, is perceived subconsciously as a danger signal, even during sleep [15]. The body reacts to noise with a fight or flight response, with resultant nervous, hormonal, and vascular changes that have far reaching consequences [16]. Recent studies show that noise is now recognized as a serious health problem in our modern societies [17]. Both auditory and non-auditory effects are prevalent among the workers/operators working in a noisy environment. The non-auditory deleterious effects of noise include: annoyance, loss of memory, and sleep disturbances [18]. Annoyance has been reported to lead to stress responses, then symptoms and then illness [19]

Noise pollution interferes with the ability to comprehend normal speech and may lead to a number of personal disabilities, handicaps, and behavioural changes. These include problems with concentration, fatigue, uncertainty, lack of self-confidence, irritation, misunderstandings, decreased working capacity, disturbed interpersonal relationships, and stress reactions. Some of these effects may lead to increased accidents, disruption of communication in the classroom, and impaired academic performance [14, 17, 20]. It also causes stress, mental health effects and neurobehavioral effects. [19, 21, 22]. The effects of noise pollution on cognitive task performance have been well-studied. Noise pollution impairs task performance at school and at work, increases errors, and decreases motivation. [23, 24]. A noise exposure may thus be extremely disturbing in education when the noise masks auditory information required for the on going activity [25].

The World Health Organization (WHO) permissible noise level in an office environment is between 55-65 dBA, (A-weighted decibels) and exposure for more than six hours a day to sound in excess of 85 dBA is potentially hazardous to health [26]. The legal regime on Noise Pollution in Nigeria can be considered under two main headings. The common law and the policy and statutes but Nigeria does not have specific legislations on noise pollution as is the case in countries like the United States of America and United Kingdom.

The use of generators in institutional settings has led to the disapperance of a scerene and conducive environment for learning and performance. This study therefore, assessed noise levels from portable generators and its perceived attendant effects on occupants of an institutional building.

2. Material and Methods

2.1. Study Area

The study was carried out in the Oladele Ajose building of Faculty of Public Health, University of Ibadan, Nigeria. It was named after the first African Professor of Preventive and Social Medicine, Professor Oladele Ajose. It houses the Departments of Epidemiology Medical Statistics and Environmental Health, Health Promotion and Education, Health Policy and Management, Community Medicine and the Adetokunbo Lucas Public Health library. The building commissioned over two decades ago is divided into the new and old complexes. It is located at about 200m from the main gate of the University College Hospital [27]

2.2. Selection of Locations for Noise Level Assessment

Six locations within the Oladele Ajose building (OAB) were selected by stratified sampling for environmental monitoring. The six locations selected are presented in table 1.

Table 1. *Selected locations for noise measurement.*

Location	Description
ELR	Environmental Health unit lecture room
ALP	Adetokunbo Lucas Public health library
EME	Epidemiology, Medical Statistics and Environmental Health main office
HPR	Health Promotion and Education computer room
CMR	Community Medicine lecture room
RDL	Resident doctors lounge

2.3. Study Design

A cross-sectional survey was used which involved questionnaire administration and determination of environmental noise levels at different time intervals.

2.4. Study Population

This included staff, students and business operators, above 18 years of age who gave informed consent to participate in the study. Fifty participants were randomly selected to participate in this survey.

2.5. Materials and Tools

2.5.1. Survey

A semi-structured self-administered questionnaire that included questions on socio-demographic information, occupational history, hearing status information and perceived health effects associated with exposure to noise

was used to elicit information from respondents.

2.5.2. Noise Measurement

Noise levels from electric generators were measured using a factory calibrated AEMC sound meter (SLM), which was set at the slow response mode with A-weighting (A-weighted decibels or dBA). Measurements were conducted three times a day 8am-10am, 12pm-2pm, and 4pm-6pm in the indoor and outdoor environment of the selected locations in the building.

2.6. Statistical Analysis

Data collected were analysed using Statistical Package for Social Sciences (SPSS) version 16 at 5% level of significance. t-test was used to compare the means at the different time interval.

3. Results

3.1. Socio Demographic Information

The mean age of respondents was 35.14±8.84 and ranged from 20 to 54 years. Majority of the respondents 52.0% were females. A large proportion of the respondents (86.0%) had tertiary education, (10.0%) had secondary education while 2 (4%) had primary education. Majority of the respondents were lecturers (24.0%) while others were clerical staffs (17.0) students (18.0%), sales persons (12.0%), doctors (12.0%), laboratory technologist (8.0%) and data analyst (6.0%). A good proportion of the respondents (38.0%) were in the age group 30 – 39. Age group 20 – 29 accounted for 30.0% of the respondents while 26.0% and 6.0% of the respondents were in the age group 40 – 49 and 50 – 59 respectively (see figure 1).

3.2. Occupational History

Majority (80.0%) of respondents had worked more than a year in Ajose building while 68.0% spends more than 8 hours a day at work and only 12.0% spend less than 8 hours a day at work (Table 3).

Table 2. *Socio-demographic characteristics.*

Variable	Options	(%)
Sex	Male	48.0
	Female	52.0
Religion	Christianity	84.0
	Islam	14.0
	Traditional	2.0
Ethnicity	Yoruba	82.0
	Hausa	2.0
	Igbo	16.0
Occupation	Clerical staffs	17.0
	Data analyst	9.0
	Sales person	12.0
	Lecturers	24.0
	Doctors	12.0
	Laboratory technologist	8.0
	Students	18.0
Educational status	Primary	4.0
	Secondary	10.0
	Tertiary	86.0

Table 3. *Occupational history.*

Variable	Options	%
How long have you been working here?	Less than 6 months	4.0
	Greater than 6 months	16.0
	More than a year	80.0
How many hours a day are you at work?	Less than 8 hours	12.0
	8 hours	20.0
	Greater than 8 hours	68.0
Do you wear hearing protection devices at work?	Yes	4.0
	No	96.0
Is your workplace noisy?	Yes	60.0
	No	40.0
If yes, I want a quieter workplace?	Yes	52.0
	No	8.0

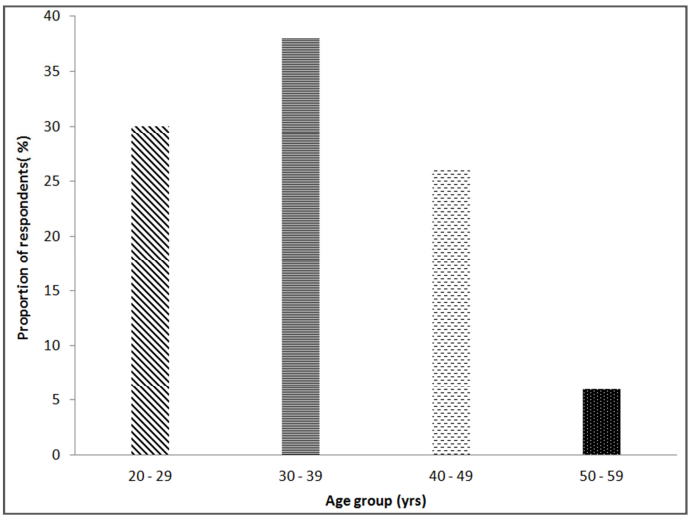

Fig. 1. *Age group of respondents.*

3.3. Hearing Status of Respondents

From the survey (see Table 4), 24.0% of respondents experience difficulty in hearing clearly when at work. 16.0% reported hearing problems with receiving calls over the telephone while 18.0% find themselves asking people to repeat themselves when they talk to them.

Table 4. *Hearing status information.*

Variable	(%)
I find it difficult to hear clearly when at work.	24.0
I have a problem hearing over the telephone	16.0
I find myself asking people to repeat themselves when they talk to me	18.0
In a gathering, I find it difficult to differentiate or pick out a specific voice talking to me.	8.0
I find myself knowingly or unknowingly reading lips when people talk to me.	8.0

3.4. Noise Related Health Problems

Table 5 shows the noise related health problems suffered by respondents. The major complains of the respondents include tinnitus (34.0%), sleeplessness (68.0%), tiredness (60.0%), ear pains (68.0%), headaches (40%) and annoyance (28.0%).

Table 5. *Noise related health problems experienced by respondents in the last six months prior to this study.*

Health problem	(%)
Tinnitus	34.0
Ear pains	68.0
Headaches	46.0
Tiredness	60.0
Sleeplessness	68.0
Annoyance	28.0

3.5. Noise Measurement

The mean noise level for the sampled locations at the different time interval is presented in Table 6a and 6b. The mean indoor and outdoor noise level in all the sampling locations exceeded the WHO guideline limit of 35dB and 55dB respectively.

Table 6a. *Noise levels between different locations and period in comparison with the WHO standard.*

Selected locations	Location of sampling unit	Time of sampling	Mean noise levels (dB)	WHO Standard (dB)
EME		8am-10am	70.10±6.10	
	Indoor	12pm-2pm	69.90±6.86	35
		4pm-6pm	65.76±4.96	
		8am-10am	71.74±5.66	
	Outdoor	12pm-2pm	72.90±7.23	55
		4pm-6pm	68.28±7.46	
ALP		8am-10am	53.40±4.25	
	Indoor	12pm-2pm	57.82±7.63	35
		4pm-6pm	60.20±6.78	
		8am-10am	58.15±4.53	
	Outdoor	12pm-2pm	61.80±6.12	55
		4pm-6pm	59.36±7.22	
ERL		8am-10am	68.40±5.65	
	Indoor	12pm-2pm	66.80±5.74	35
		4pm-6pm	63.69±3.78	
		8am-10am	70.66±3.44	
	Outdoor	12pm-2pm	71.72±6.35	55
		4pm-6pm	66.47±6.24	

Table 6b. *Noise levels between different locations and period in comparison with the WHO standard.*

Selected locations	Location of sampling unit	Time of sampling	Mean noise levels (dB)	WHO Standard (dB)
HPR		8am-10am	73.38±9.08	
	Indoor	12pm-2pm	74.64±8.02	35
		4pm-6pm	75.11±9.51	
		8am-10am	74.26±6.36	
	Outdoor	12pm-2pm	76.18±8.37	55
		4pm-6pm	78.15±7.07	
CMR		8am-10am	72.24±7.81	
	Indoor	12pm-2pm	73.55±6.23	35
		4pm-6pm	74.46±8.12	
		8am-10am	75.44±5.26	
	Outdoor	12pm-2pm	77.62±7.34	55
		4pm-6pm	79.21±7.61	
RDL		8am-10am	63.52±3.24	
	Indoor	12pm-2pm	61.73±6.32	35
		4pm-6pm	60.26±8.45	
		8am-10am	64.54±6.61	
	Outdoor	12pm-2pm	65.61±4.26	55
		4pm-6pm	70.28±6.48	

4. Discussion

The noise level estimates in Ajose building both in the indoor and outdoor environment at the different time interval exceeded the World Health Organization (WHO) limits and most of the respondents spend more than 8 hours a day at work.

The WHO guideline set the maximum noise levels in classrooms and outdoor playgrounds at 35dB and 55dB respectively [28]. The background noise level of 35 dB(A) LAeq in classrooms is based upon the assumption of 55 dB(A) for a typical teacher's voice level at a distance of 1 m, and of the need for a signal to noise ratio of 15 dB [29]. The minimum noise level recorded classroom in this study was 65.76dB and this significantly higher than the WHO guideline limit. A recent study conducted in Ibadan revealed high generator noise level of between 91.2 and 100.5 dB(A) [30].

Noise health effects are the health consequences of elevated sound levels. Elevated workplace or other noise can cause hearing impairment, hypertension, ischemic heart disease, annoyance, and sleep disturbance [31, 32, 33, 34]. Our study revealed that the major health problems experienced by respondents six months prior to this study include tinnitus, ear pains, headache, sleeplessness, annoyance among others.

In addition, studies have shown that exposure to noise disturbs sleep proportional to the amount of noise experienced in terms of an increased rate of changes in sleep stages and in number of awakenings [35]. Findings of this study revealed that 68% of the respondents experienced sleeplessness six months prior to the commencement of the study due to exposure to noise at elevated levels.

Elevated noise levels can create stress, increase workplace accident rates, and stimulate aggression and other anti-social behaviours [36]. According to Cohen [37] and Gunn [38] noise has been shown to intrude into individual privacy and also causes annoyance, fear and mild anger. Annoyance as well as negative effects on performance has been shown to increase with increasing sound level, tonal character of the noise and variability of the exposure [39]. Our study showed that a good proportion our respondents usually get annoyed as a result of noise exposure.

The study was limited in that we were not able to conduct audiometric test on respondent to ascertain their hearing status as this would have helped in the linkage of the exposure factor to the health problems experienced by the respondents.

5. Conclusion

Generator noise level and perceived health effects experienced by residents of Oladele Ajose Building were assessed in this study. Findings of this study showed that noise levels in Oladele Ajose building were significantly higher than the WHO permissible limit. Major health problems experienced by participants include ear pains, tinnitus and sleeplessness. There is need for design of proper containment measures which would help in the reduction of the hazards associated with the usage of these machines. In addition, alternative energy sources like biogas, solar power should be harnessed while the use of electric generators in the building should be discouraged.

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