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Assessments of Noise Levels From Noise Sources in Akure, Nigeria: A Preliminary Study

Francis Olawale Abulude[1, 2*], Samuel Dare Fagbayide[3], Akinyinka Akinnusotu[4]
[1]Department of Chemistry, Federal University of Technology, Minna, Niger State, Nigeria
[2]Science and Education Development Institute, Akure, Ondo State
[3]Department of Agricultural and Bio-Environmental Engineering, The Federal Polytechnic, Ilaro, Ogun State, Nigeria
[4]Central Analytical Laboratory, Science Laboratory Technology Department, Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria

Abstract

Background: Noise injury and hearing loss are significant problems in Nigerian community. The hearing loss sustained from noise injury can have disabled personnel and social consequences for the affected persons and their families. This study was carried out to quantify the noise level of over eighty (80) different sources using the sound level meter (GB: 2266204) at different locations in Akure, capital of Ondo State, Nigeria. Standard procedure specified by the manufacturer was strictly followed and the results were statistically analyzed. The range of results obtained were: household products (48.5±0.5 - 105.7±3.2dBA), traffic (60.9±0.6 - 77.5±1.2dBA), market (55.0±0.5 - 68.1±0.7dBA), automobile/ workshop (65.7±0.5 - 105.7±3.3dBA), poultry/livestock (48.7±0.5 - 60.7±0.7dBA), musical instrument (45.0±0.5 - 79.3±1.3dBA), residential areas (41.2±0.5 - 46.3±0.5), farm machinery/tools (76.4±1.2 - 99.3±1.5dBA), hospital (48.0±0.5 - 61.1±0.6dBA), and baby toys (42.7±0.5 - 50.9±0.5dBA). The results showed that many of the sources exceeded the standard limits proposed by WHO, FEPA, OSHA and that of countries like Germany, Australia, Japan, Korea, and the Philippines.

Conclusion: The results show the existence of noise pollution in Akure, thus the need for noise control in this area. It is recommended that the Nigerian government should put an effort to reduce noise pollution in the country. This can be achieved by creating awareness of the danger of noise pollution and putting up necessary sanctions.

Keywords: Noise, Deafness, Sound Meter, Nigeria, WHO.

Introduction

Noise is a sound that causes disturbance, but at an elevated level above the international standard, it is pollution. Noise pollution like other pollution has problems associated with it. According to Mercola [1], the attendant problems include stress, high blood pressure, hearing loss, heart disease, sleep disturbance, and more. According to a study in US, a reduction of noise by 5dB has an influence on the prevalence of high blood pressure and coronary heart disease by reducing them to 1.4% and 1.8% respectively. Further, in the submission, the economic advantage of noise pollution reduction was estimated at $3.9 billion/ year [1].

If a location's noise level becomes constant, the environment of the noise pollution gets noisier. By this, noise pollution spreads far and wide and it becomes difficult to find a quiet place [2]. In serene environments, noise is not only a nuisance, but also interferes with the performance of the activities of the area, for example, in education [3, 4] and school settings, students; and teachers feel uncomfortable. While in noisy hospital, patients will be adversely affected. According to Yuen [5],

*Email: walefut@gmail.com

continuous exposure to noise of 85-90dBA may cause hearing loss and the change of the threshold sensitivities of hearing.

WHO release data on 10 million adults and 5.2 million children US citizens suffering from irreversible noise-induced hearing impairment. Over 250 million people throughout the world in their daily activities are prone to the dangerous levels of noise [6].

In Nigeria, noise has become a nuisance due to increases in population, vehicular movements, residential and industrial activities. This problem is traceable to a number of perceived factors which are classified as: i. Socio-economic and cultural factors; ii. Attitude or behavioral factors; iii. the structure of Nigerian cities [7]. Ganiyu and Ogunsote [8] classified noise sources into internal (activities, office equipment and operation of building services) and external (sound outside the building). The Government has now taken bold steps to reduce the menace by enacting Laws which are strictly pursued. Any erring religious gathering or settings, industries and social joints who flout these laws are sanctioned appropriately (Liable on conviction to the penalty specified in section 36 or 37 of the Federal Environmental Protection Agency Act.). In Nigeria, the standard noise limit enacted by Federal Environmental Protection Agency (FEPA) is 55dB and World Health Organization 60dB [9].

This study was undertaken in Akure, capital of Ondo State, can be classified as a relatively medium-large urban city, located in the South-western part region of Nigeria. The city has a population of 421,100. The geographical coordinates are 5° 10' 0", East, 5° 14' 0" (Latitude), 7° 14' 0", 7° 18' 0"North (Longitude) at an elevation/altitude of meters, with an average elevation of 353 meters [10]. Studies have been carried out in Akure on Buildings [8], Traffic [11], Industry [12], but none delved into general noise sources.

The aim of the study was to quantify the noise level from over eighty (80) different sources. This work is limited to the measurement of noise levels of sources. Work is on-going to study the effects of noise on the environment and health effects on people.

Material and Methods

Akure, capital of Ondo State, Nigeria is the study area. It is a fast growing urban town. The noise levels were taken at different locations within the vicinity of the study. Eighty noise sources were used for the research. The study was carried out on various noise sources using the sound level meter (GB: 2266204, made in China) (Figure-1): Measurement range 30dBA - 130dBA, accuracy (± 1.5dB), frequency range (31.5Hz – 8kHz) and power supply (3*1.5V AAA battery). The meter was switched on, after 1sec the screen LCD panel displayed the sound level of the current environmental noise, then MIN button was pressed, a value appeared, replacing the current environmental noise when this value was stabilized, it was read as the MIN sound level of the noise source. The same procedure was applied to the MAX reading. Noise level readings (dBA) were taken directly from the noise sources. The generated values (triplicates) were statistically analyzed using Minitab 16 Statistical Software.

Figure 1-Sound level meter (GB: 2266204, made in China)

Results and Discussion

House Products

Noise levels of household products are shown in Table-1. The highest noise level was recorded for grinding machine (105.7±3.2-116.1±3.7dBA), followed by Generator (91.0±2.8 98.8±2.8dBA) and phone ringing tone (70.6±1.2 - 89.2±2.4dBA). These noise values are categorized as extremely dangerous and highly dangerous respectively (Table-2). In comparison, of our results with USEPA [13], WHO and other countries' standards (Table-3), it was observed that our results were far above the limits Tables-(4 and 5). All the noise sources levels are shown in Figures-(2-4). The mean noise level obtained exceeded the WHO limit of 50dBA recommended for residential areas. There was a significant test difference ($p < 0.05$) of the noise values in the study areas and the WHO standard. The values (97.60dBA) obtained for generators by Menkiti and Agunwamba [14] was in agreement with our results for the generator. Likewise, the sound levels recorded for refrigerators and washing machines in this study were in agreement with that of Agharifard [15]. According to Agharifard [15], over 40% of Europe's population has the problem of exposure to noise above 55dBA, the author confirmed that washing machines, extractor fans, and vacuum cleaners are the major sources of noise pollution in terms of household products. Garg and Maji 10] proposed 55dBA for refrigerators and freezers; washing machine, microwave oven, electrical fan, and vacuum cleaner-70dBA; food processors - 90dBA, blender - 100dBA; lawn mowers - 100dBA. In a nutshell, the household noise limits should preferably be considered in terms of sound power level [16].

Traffic

Eleven roads were monitored in this study (Table-1, seven of which are shown in Figure-2). The mean results of the levels ranged between 60.9±0.6dBA and 77.5±1.2dBA. As expected, the expressway had the highest value. In Akure, the expressway is a major road linking the north, east, south and the west of Nigeria. Heavy vehicular movements always take place throughout the 24hrs. The only days that there are reductions in the noise levels are on Sundays, festivity days and holiday periods. The causes of noise on our roads are: unnecessary uses of horns, wear, and tears of vehicles, many vehicles may either not have silencers or it may be leaking, and heavy vehicle movements, adding to that, many of the houses, shops, markets, garage/motor parks were sited along the roadsides. Other reasons for the elevated levels of noise are from the indiscriminate use of loudspeakers/musical instruments for advertisements, religious activities, nightclubs/social engagements, and pedestrian movements. These findings corroborated with the findings of Ganiyu and Ogunsote [8], in their study to determine the sources of environmental pollution in Akure. In a study conducted by Seong *et al*. [17] in Fulton County, Georgia they discovered that over 48% of the population was exposed at day time to noise levels exceeding the recommended limits (55dBA and 32% of the population was exposed to night time noise levels exceeding 50dBA. Lee *et al*. [18] conducted a traffic-related noise in US. It was found that there were correlations between urban traffic and noise. The methods used predicted that New York City had the highest number of vehicles and highest noise levels, followed by Los Angeles and Atlanta. In a study conducted by Schlittmeier *et al*. [19] in Germany, they found that people are less annoyed with a road traffic noise 50dBA than a loud road traffic noise of 70dBA. In France, a study conducted by Méline *et al*. [20] showed that there were relationships between transportation noise in the study area (workplace) and blood pressure. Singh *et al*. [21] found that there were auditory effects due to traffic noise on traffic policemen in India. In Sweden, there were no significant relationships between traffic load and self-reported hypertension or cardiovascular diseases [22]. Research by Shannon [41] has shown that prairie dogs, which live near roads and urban areas, have significantly lowered their foraging and increased their vigilance behavior when exposed to road noise. Traffic noise has effects on the foraging efficiency of bats and changed vocal communication in frogs.

Traffic noise can be minimized by constantly maintaining roads use of sound barriers, reducing vehicular speeds, routing of freight trucks, use of buses (electric), public transit, bicycles, and walking.

Musical Instrument

Results of musical instruments were between 45.0±0.5dBA (Tambourine) and 79.3±1.3dBA (Loud Speaker) (Figure-3). Our results are below the levels (87-95dBA) recorded for brass, wind, string, and voice used in a practice session at the Music Research Institute of University of North Carolina [51]. The differences could be as a result of the amplified engine, which aided the volume of the speaker. Our results were far below the Decibel (Loudness) Comparison Chart issued by H.E.A.R. hearnet.com

[23]. The results showed that most of the musical instruments produced sounds that could be grouped under highly risky, dangerous, and highly dangerous according to EPA sensitivity zone (Table-2). In Akure between the hours of 7pm-3am, there is the high influx of nightclubs, disco, and parties. Most of these places use live bands. The people that will be affected by the sound are restaurant staff, waiting for staff, technical staff, service girls/attendants, and customers. It is recommended that staying in such an environment should not be more than 2hrs (Table-4). If one wants to spend more than this time, hearing protection devices should be used [24].

Studies reported that between 30 - 50 % of musicians have hearing problems [25]. In advanced countries of the world, musicians wear earplugs that are specially designed for playing music. The earplugs assist someone to hear all of the music at a reduced sound level. A study in Canada reported the effect of noise on musicians, it was discovered that in an orchestra people were exposed to sound levels as high as 94dBA [25].

According to Cabrera and Lee [26], music therapy is effective in reducing the dosage of noise pollution to a healthy human being. It has a beneficial impact on patient anxiety and many other physiological characteristics. Combinations of behavioral change, administrative and engineering measures could reduce noise levels below the recommended limit.

Hospital

Our results from hospital premises showed that the location is a little bit noisy. The noise levels obtained ranged from 47.3±0.5-61.1±0.6dBA (Figure- 4). The highest value was recorded in the account section of the hospital. These were within the limits recommended by WHO and in some selected countries (Table-5). The reason for the high results recorded could be due to many people present in the reception room. During the measurement time, accident victims were brought into the emergency section of the hospital many of the sympathizers were crying on top of their voices. Also, there is a major road beside the hospital premises, with high vehicular movements and indiscriminate sounding of horns which might also elevate the results. The results of the study compared with 51.3-59.1dBA obtained for sound levels from intensive care units in five UK hospitals [27]. In a study undertaken by Turkish cardiac surgical ICU [28] and American pediatrics ICU [29], they obtained results (50-105dBA) higher than ours. The WHO recommended that hospital environments should not exceed 35dBA and 40dBA at night and at day respectively.

Many studies on noise pollution in the hospitals have summarized the reasons for elevated levels of pollution to: heavy visits of patients, visitors and vehicular movements (engine noise, horns and public vehicles), discussions between members of staff and visitors, equipment and appliances (Air conditioners, mobile phones, alarms of instruments, power generators). According to Baloye and Palamuleni [30], the human ear is sensitive to sound at different frequencies (between 20Hz-20kHz), the sensitivity depends on the nearness of the ear to the source of the noise. B etween 45dBA and 60dBA have been suggested for a normal conversation of people at a distance of 3-6 feet apart. A noise limit of 80dBA will adversely affect the ear, while > 130dBA will cause pain [31].

In India, there was a study conducted by Ramesh *et al*. [32] in an institutional hospital, the methodology used to reduce noise levels was fixing the stands of all furniture with rubber shoes, changing all metallic files to plastic files, and lowering of the phone ringing tone to a minimum audible level. They obtained significantly reduced noise levels. Also, reduction of alarms and phone tones, providing 'No Noise' signs, awareness campaigns for staff assists in reducing noise [33].

Building Construction

Table-1 and Figure-4 depict that Block Making Machine had the highest value of 91.5±1.5dBA. These values are far above the limits for permissible noise exposure proposed by WHO and several countries (Table-5). Throughout the world, noise pollution affects the quality of life. Noise can also have a harmful (negative) effect in the workplace. Building construction workers get exposed to noise continuously for what they do and also from what is going on around them. In a building construction, electricians have a reputation as a member of a quiet trade, but if they continuously work beside a carpenter, bricklayer, and welder (those who produce noise), they are prone to the hazards of noise pollution. In the mid to late 1990, NIOSH studies showed that 90% of construction workers have some degree of hearing loss [34]. The research also revealed that by age twenty-five, the average carpenter's hearing is equivalent to an otherwise healthy fifty-year-old male who hasn't been exposed to noise. About 30 million workers in the US are exposed to hazardous sound levels on the job [34]. Many industry workers like construction, agriculture, mining, manufacturing, utilities, transportation, and the

military are exposed to loud sounds. Ng [35] research showed that there were significant effects on the range of frequency heard, distractibility, disturbances during conversation and television-watching. It was noted also that the effects were more severe on residents nearest to the construction site than those further away. Ng [35] concluded the study by recommending that the administration, which has the plan of constructing new buildings near hostels, should take necessary measures to minimize the effects of noise on residents.

Baby Toys

Mean results of the baby toys used for this study ranged from 42.7±0.5dBA to 50.7±0.5dBA. This sound level was within the limits recommended by WHO and several countries (Table-5). In a study using infant sleep machines, out of the lots used, three machines produced output levels of 85dBA. It was noted that if played at these levels for about 8 hours, the limits of accumulated noise exceeded the recommended noise levels and there are risks of noise-induced hearing loss on the children [36]. They concluded that regular exposure to baby toy noise could affect hearing, speech, and language development. A study on musical toys found that 1 out of 4 were too loud at a distance of 30cm from the ear and 88 out of 90 toys were too loud when placed closer to the ear [49].

Farm Machinery/Tools

The results ranged from 76.4dBA (Flower Pruning Machine) 99.3dBA (Cassava Grating Machine, without a silencer). According to WHO [9], these values can be graded into profound impairment. The performer will be unable to hear and understand even a shouted voice (Table-6). The results of this study were as per with the results of Depczynski *et al*. [37]. There were few differences in some types of machinery between our results and theirs. This may be as a result of high variability around the mean noise level due to some machinery producing enormously large amounts of noise, variation because of age, manufacturer, horsepower, condition, and power source. Generally, most farm tools are noisy. It is advisable that the length of exposure should be reduced before hearing damage is done. The risks are increased if the tool is old and worn.

Poultry/Livestock

Results showed that the mean values are 48.7±0.5-60.7±0.7dBA. Our results were lower than 82.5-113.9dBA obtained from feed mills in Ibadan, Nigeria [54].Bulldog barking had the highest noise level measured. A sound level of 50dBA has been recommended to prevent disturbance to animals or personnel [38]. The sources of noise in the animal house can come from technical devices, routine works, mechanical ventilation, animals' activities, and by their vocalizations [39]. An exposure to noise levels at ≥ 85dBA sound pressure level for a long period of time can cause permanent hearing loss through cochlear damage [24]. In a study carried out by Pfaff and Stacker [40], it was found that noise levels in animal facilities were approximately 60 episodes/0.5 h at ≥ 90dBA in the morning and > 60 episodes/0.5 h at ≥100dBA in the evening.

Animals are sensitive to noise and this has effects on their productivity and behavior. The effects depend not only on its loudness (dBA), frequency (Hz), but also on the hearing tendency of the species and breeds, the age and physiological state at the time of exposure. Again, the effects also depend on the types of sound the animal has been subjected to during its lifetime and to the predictability of the acoustic stimulus [42].

General

The results obtained in this category were: baby crying (1month-1year old) (56.6±0.5)dBA, quarry (120.6±3.5)dBA, rainfall (50.4±0.5)dBA, and fish frying (46.7±0.5)dBA. No doubt quarry noise level was the highest. This was stone blasting and vibration of the ground. Dudek *et al*. [43] suggested in their study that cognitive control processes contribute to an intentional bias to infant signals (noise). Our results on baby cry were far different from sound levels of 99-120dBA reported by Carney and Logan [44]. Our results of noise levels from quarries were compatible with those (85.5dBA to 102.7dBA) from a quarry in Ghana [45], but lower than those from South India of 105 and 111dBA [46]. Gupta *et al.* [46], recommended safe zone limit for a quarry, which should be 30m, meaning that noise will not affect the premise beyond this distance. Variation in noise levels is influenced by topography, geological discontinuities, rock properties, distance and presence of wind. The average noise levels of rainfall in Kenya were 58.3-64.6dBA [47]. They were above our results. According to the authors, high levels could cause both physical and psychological effects on the human bodies. It was further stated that the meteorological factors (Air temperature, precipitation, and wind) contribute so much to the spread of noise.

Table 1-Noise Levels (Min and Max readings)from Noise Sources

Parameters	Minimum	Maximum
Household Products		
Fridge	48.5±0.5	62.7±0.5
Television	60.6±0.777.4±1.5	
Blender		
Juice Maker		
Fan	68.7±0.7	77.7±1.5
Washing Machine	48.3±0.5	75.3±1.2
Phone	70.6±1.289.2±2.4	
Sewing Machine	49.7±0.569.9±0.7	
Grinding Machine 105.7±3.2	116.1±3.7	
Generator	91.0±2.8	98.8±2.8
Stone Grinder (Local pepper grinder)	43.6±0.5	55.7±0.6
Traffic		
Arakale Road	60.9±0.6	78.3±1.2
Oba Market Road	71.1±0.8 97.2±2.6	
Esso Road	70.9±0.887.4±1.3	
First Bank Round about	65.8±0.6	71.0±1.0
Oba Ile (Airport Road) Road	62.8±0.6	70.2±1.0
General Hospital Road	64.1±0.6	79.4±1.3
Union bank Round about	61.4±0.6	79.4±1.3
NEPA Junction	68.9±0.6	91.0±2.4
Araromi Junction	68.4±0.6	92.5±2.4
Fiwasaiye Roundabout	67.1±0.6	89.0±1.3
Expressway	77.5±1.2	99.8±2.4
Market		
Oba Market (Akure)	68.1±0.7	77.2±1.2
Oba Market (Oba Ile)	55.0±0.5	69.7±1.0
Arakale Market	58.5±0.574.0 ±1.2	
Automobile/Welding Workshop		
Vulcanizer Engine	70.7±1.2	100.5±3.2
Car Workshop	65.7±0.5	73.7±1.3
Motorcycle Workshop		
Car Horn	71.6±1.2	104.0±3.2
Motorcycle Horn		
Trailer/Lorry Horn		
Automobile Painting Engine	71.3±1.2	93.7±1.3
Welding with Electrode	78.7±1.3	100.8±3.2
Grinding/Cutting Machine	105.7±3.3	116.1±3.5
Poultry/Livestock		
Pig	50.9±0.5	77.9±1.2
Goat	51.2±0.5	78.5±1.3
Pullet	49.7±0.5	72.4±1.2
Cockerel	48.7±0.5	65.8±0.5
Dog (Bulldog)	60.7±0.7	107.5±3.2
Musical Instrument		
Loud Speaker	79.3±1.3	108.4±3.2
Drum Set	74.4±1.2	99.0±1.5
Bell	72.7±1.2	105.2±3.2
Tambourine	45.0±0.5	77.5±1.3
Sekere	56.0±0.5	79.9±1.3
Talking Drum (Local Name - Gangan)	65.5±0.7	80.1±1.4
Conga	71.7±1.2100.9±3.2	

Flute	50.9±0.5	71.2±1.2
Residential Areas		
Oke Eri Estate (Indoor)	41.6±0.559.1±0.5	
(Outdoor) 46.3±0.5	57.1±0.5	
Housing Estate (Oba-Ile)	41.7±0.5	66.9±0.7
Oba Afunbiowo Estate	41.2±0.5	66.5±0.5
Farm Machinery/Tools		
Hand Mower	85.2±1.4	98.3±1.5
Lawn Mower	88.4±1.5	98.9±1.5
Cassava Grating Machine (No Silencer)	99.3±1.5	104.0±3.2
Cassava Grating Machine (With Silencer)	87.3±1.5	101.4±3.2
Flower Pruning Machine (Challenge Xtreme)	76.4±1.2	92.8±1.5
Tractor Engine	80.5±1.3	97.8±1.5
Hammer Mill Grinding Engine	98.7±1.8	100.1±3.2
Hospital		
Account Section	61.1±0.6	80.6±1.5
Pharmacy Department	56.6±0.5	73.6±1.2
Laboratory Unit	58.8±0.5	83.4±1.5
Eye Centre	47.3±0.5	66.6±0.7
Female Surgical Ward	48.3±0.5	69.3±0.7
Female Medical Ward	54.7±0.5	74.1±1.2
Theatre	51.7±0.5	74.2±1.2
Dental Center	55.9±0.5	74.5±1.2
Chest Clinic	59.2±0.5	70.5±1.2
Critical Care	50.1±0.5	68.2±0.6
Obstetrics and Gynecology	56.3±0.5	72.5±1.2
Family Planning Unit &53.7±0.5 Children Ward	69.5±0.7	
Male Surgical Ward	52.3±0.5	68.8±0.7
Male Medical Ward	48.0±0.5	69.6±0.7
NHIS Clinic	49.4±0.5	70.9±1.2
General		
Baby Crying (1month-1year)	56.6±0.5	82.4±1.5
Quarry	120.6±3.5	159.1±3.5
Rainfall	50.4±0.5	70.4±1.2
Fish Frying	46.7±0.5	66.2±0.5
Sawmill		
Circular Machine (Cutting)	89.4±1.5	99.2±1.7
Building Construction		
Block Making Machine	91.5±1.5	114.4±3.5
Carpentry (Roofing)	50.9±0.5	79.0±1.2
Baby Toys		
Whistle	45.5±0.5	55.0±0.5
Plastic Motorcycle (Battery Operated)	49.2±0.5	96.4±1.5
Bicycle (Battery Operated)	42.7±0.5	55.7±0.5
Plastic Machine Gun (Battery Operated)	50.9±0.5	71.2±1.2

Min (Minimum), Max (Maximum)

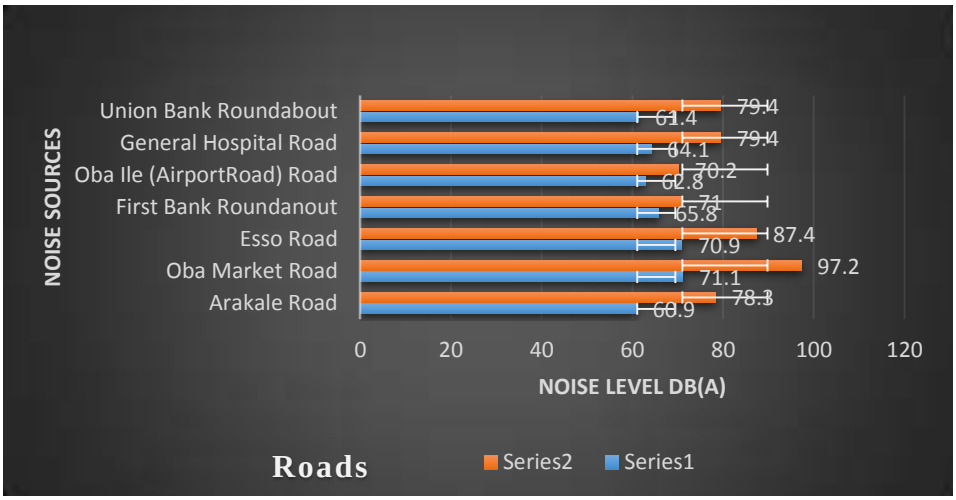
Table 2- Noise Sensitivity Zones

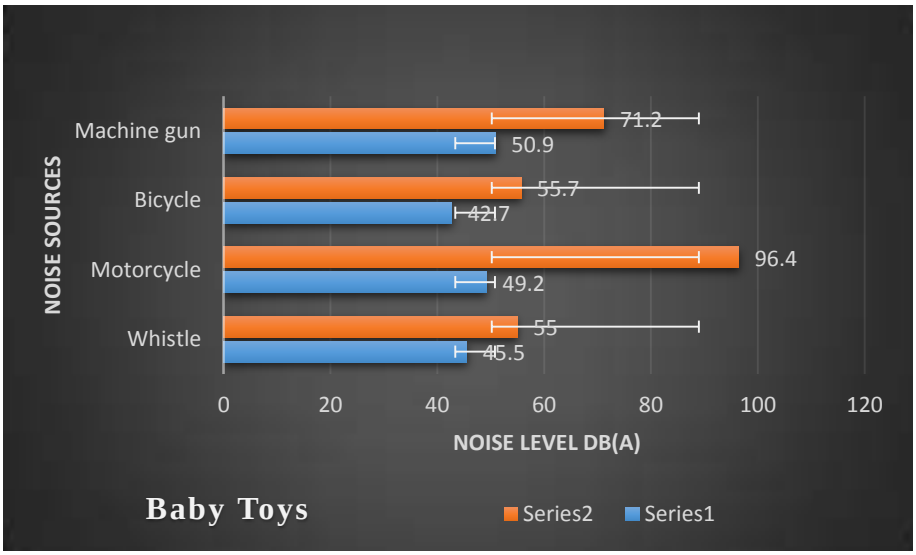
dB(A)	Sensitivity
55-<60	Risky
60-<65	Moderately Risky
65-<70	Highly Risky
70-<75	Dangerous
75-<80	Highly Dangerous
>80	Extremely Dangerous

Source: USEPA [13]

Table 3- Noise Level Standards in Selected Countries, USEPA, WHO and FEPA

Countries	Industrial		Commercial		Residential		Silent Zones	
	Day	Night	Day	Night	Day	Night	Day	Night
Australia (dBA)	55	55	55	45	45	35	45	35
India (dBA)	75	70	65	55	55	45	50	40
Japan (dBA)	60	50	60	50	50	40	45	35
US, EPA (dBA)	70	60	60	50	55	45	45	35
WHO (dBA)								
(WHO [9],(dBA)								





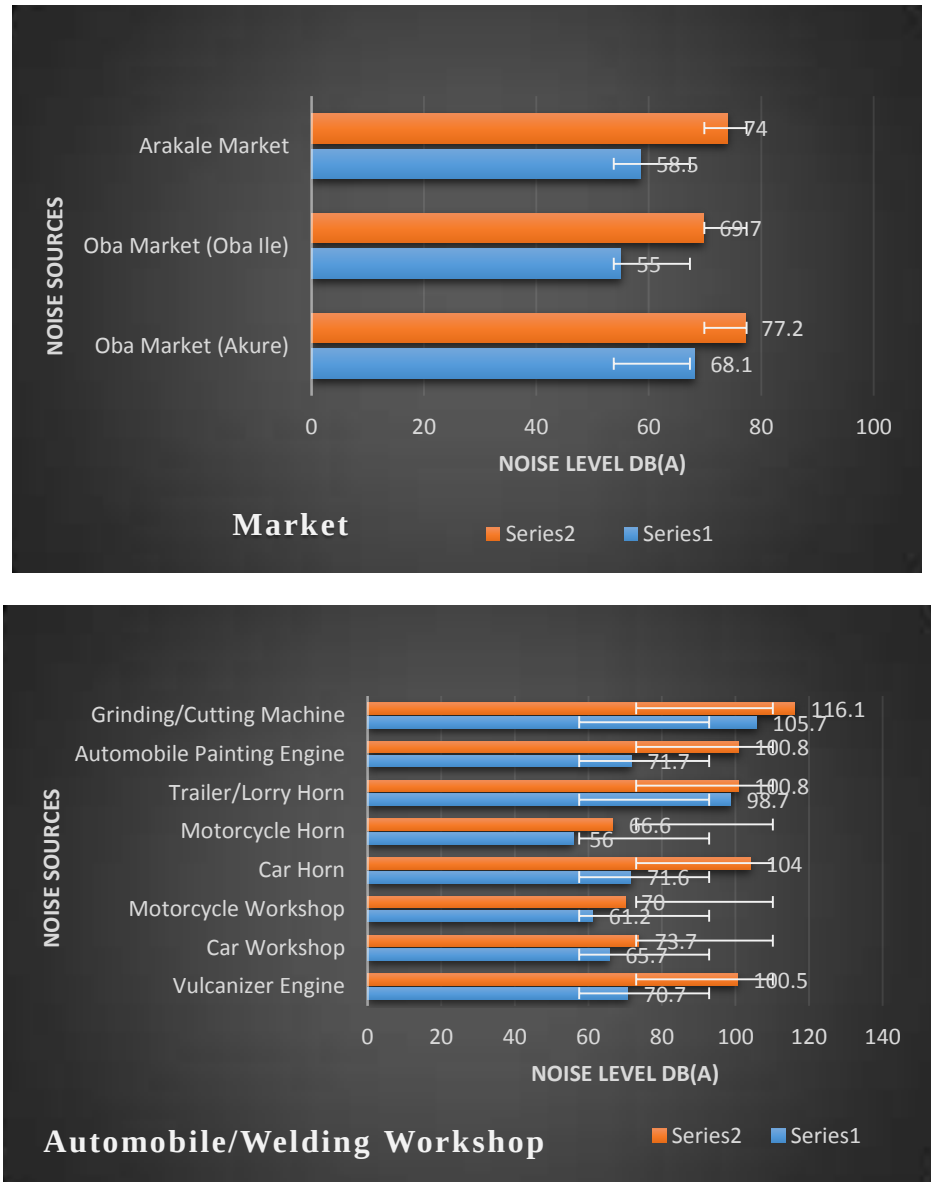
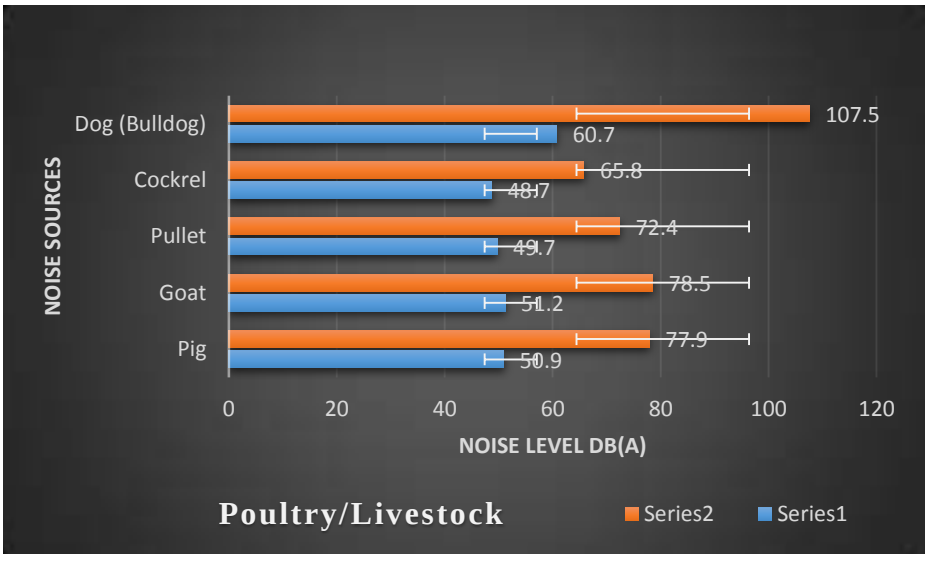


Figure 2-Noise levels of Sources of Noise (Baby toys, Roads, Markets, and Automobile/Welding Workshop)



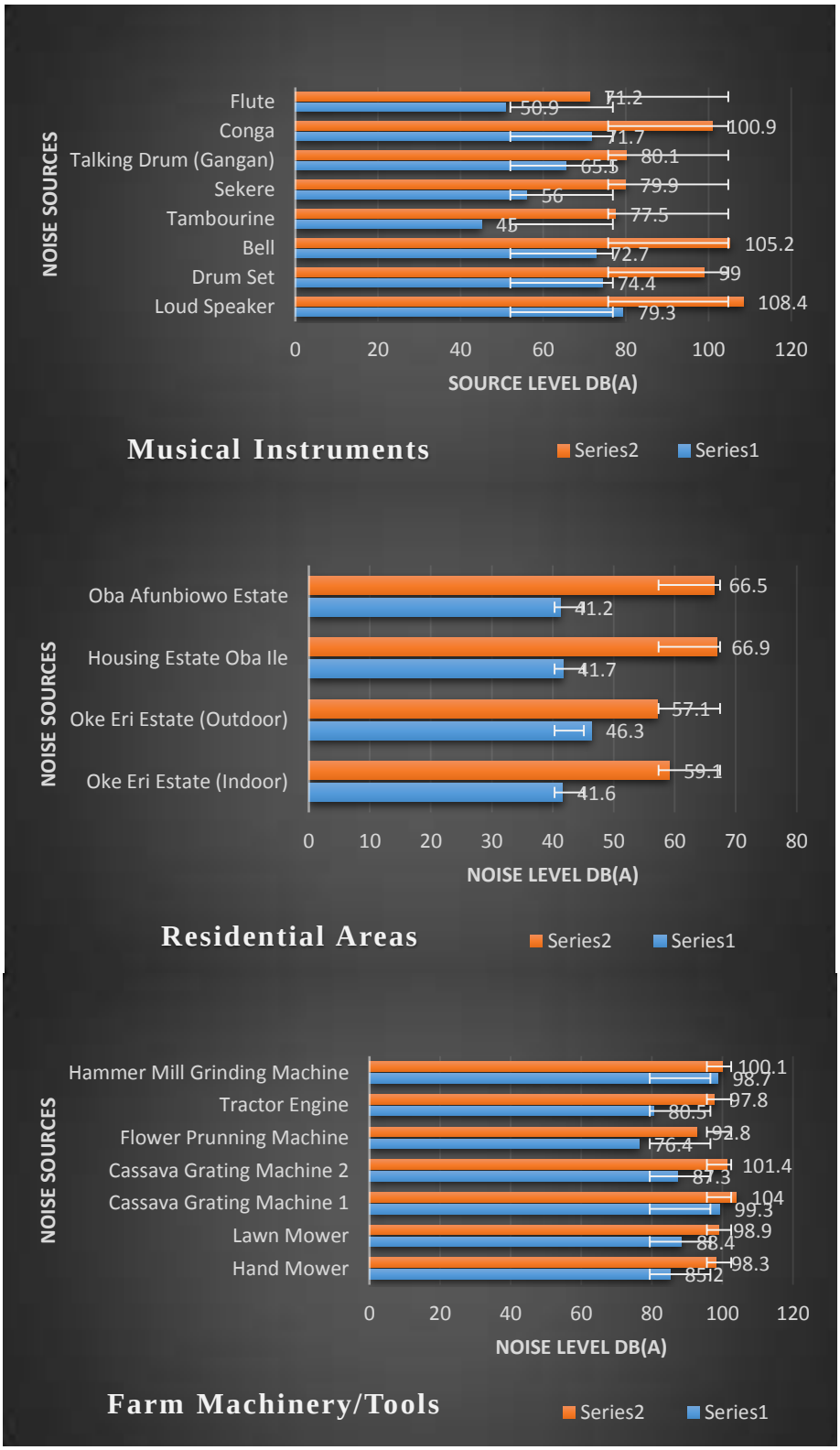
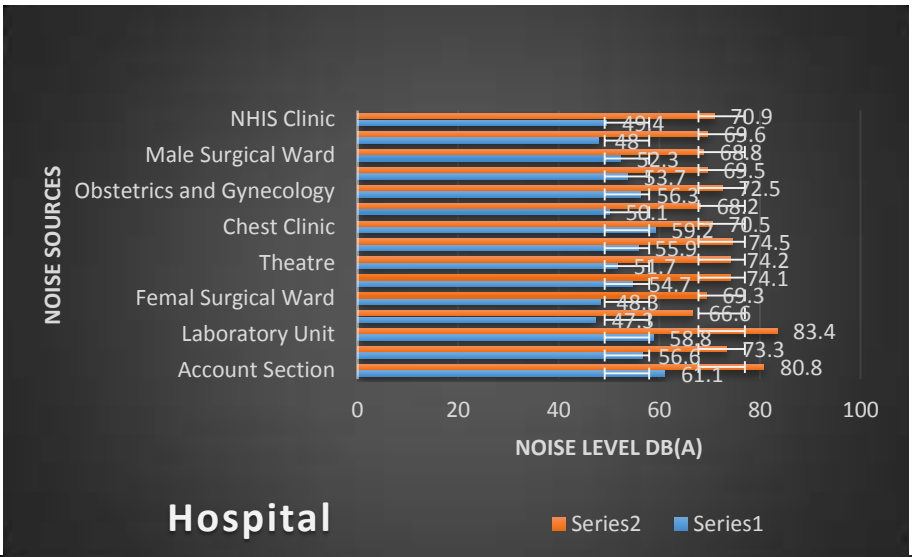
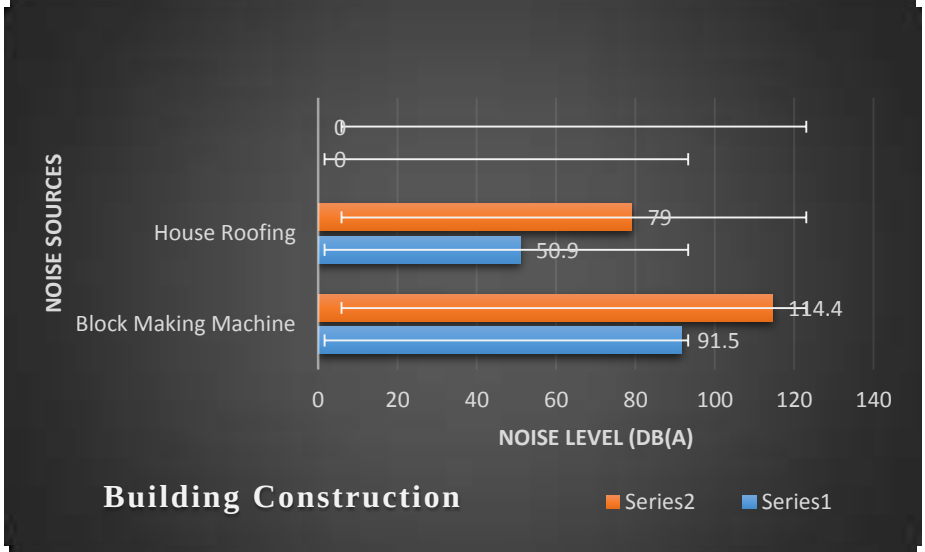
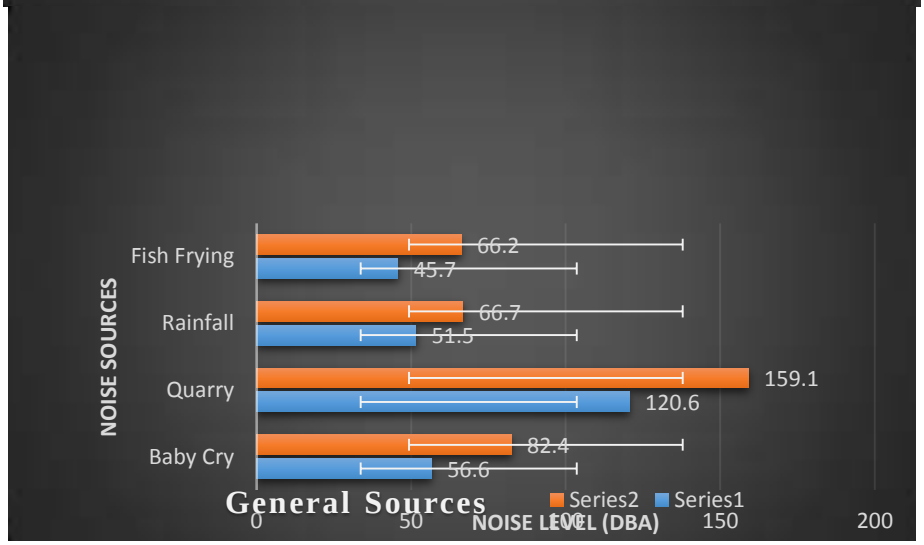


Figure 3-Noise levels of Sources of Noise (Poultry/livestock, Musical Instruments, Residential Areas, and Farm Machinery/Tools


NOISE SOURCES
NHIS Clinic
Male Surgical Ward
Obstetrics and Gynecology
Chest Clinic
Theatre
Femal Surgical Ward
Laboratory Unit
Account Section
70.9
69.6
68.8
69.5
72.5
68.2
70.5
74.5
74.2
74.1
69.3
66.6
83.4
73.3
80.8
0
20
40
60
80
100
NOISE LEVEL DB(A)
Hospital
Series2
Series1


NOISE SOURCES
House Roofing
Block Making Machine
79
50.9
114.4
91.5
0
20
40
60
80
100
120
140
NOISE LEVEL (DB(A)
Building Construction
Series2
Series1


NOISE SOURCES
Fish Frying
Rainfall
Quarry
Baby Cry
66.2
45.7
66.7
51.5
159.1
120.6
82.4
56.6
0
50
100
150
200
NOISE LEVEL (DBA)
General Sources
Series2
Series1

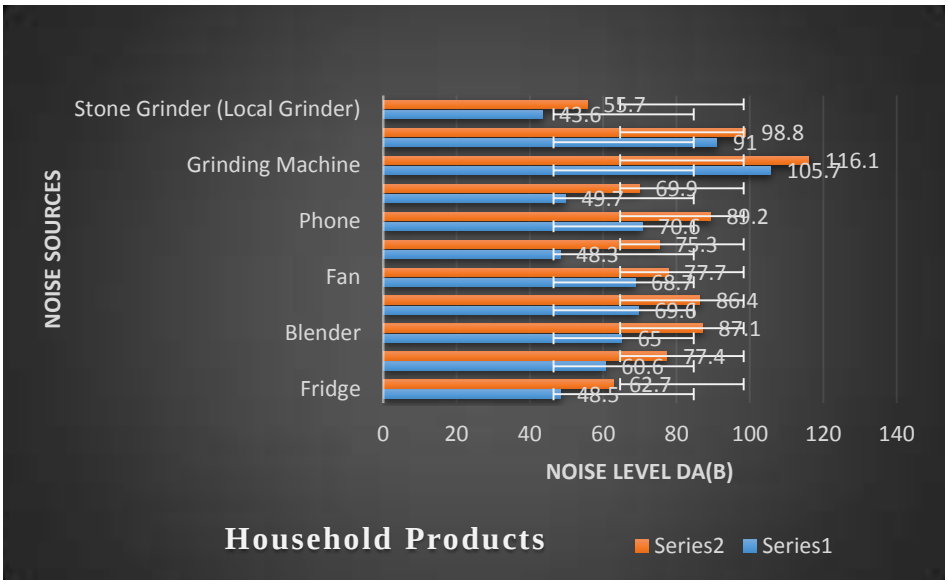


Figure 4-Noise levels of Sources of Noise (Hospital, Building Construction, General Sources and Household Products

Table 4-Limits for Permissible Noise Exposure

Duration (hours)	Noise Limits (dBA)
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
30 minutes	110
15 minutes	115

Source: US OSHA Standard [48]

Table 5-Limits for Permissible Noise Exposure Proposed by WHO and Countries

Selected noise level standards	Noise level, L_{eq} dBA	
	Daytime	Night time
WHO recommended health criteria	55	45
Germany (noise level guidelines)	45	35
Australia (recommended outdoor background noise level)	45	35
Japan (environmental quality standards)	45	35
Korea (environmental quality goal)	50	45
Philippines (environmental quality noise standards)	50	40
Malaysia (planning guidelines for environmental noise limits and control)	65	60

WHO = World Health Organization

Source: Yuen [5].

Table 6-Hearing Impairment[a]

Grade of hearing Impairment		Audiometric ISO value[b]	Performance
0	no impairment	≤25 dB (better ear)	No, or very slight, hearing problems. Able to hear whispers.
1	slight impairment	26–40 dB (better ear)	Able to hear and repeat words spoken in normal voice at 1 m.
2	moderate impairment	41–60 dB (better ear)	Able to hear and repeat words using raised voice at 1 m.
3	severe impairment	61–80 dB (better ear)	Able to hear some words when shouted into better ear.
4	profound impairment, including deafness	≥81 dB (better ear)	Unable to hear and understand even a shouted voice.

[a] Source: based on WHO (1991).
[b] International Organization for Standardisation, average of 500, 1000, 2000, 4000 Hz.

Conclusion

From the study, it could be concluded that many of the sources noise levels were above the recommended limits proposed by WHO, FEPA, OSHA and countries like Germany, Australia, Japan, Korea, and the Philippines, hence, the existence of noise pollution, and the need to control it. It is recommended that the Nigerian government should put an effort to reduce noise pollution in the country. This can be achieved by creating awareness of the danger of noise pollution. The majority of the population is illiterated and even the elites put on carefree attitudes in dealing with noise. Presently, two states in Nigeria are trying to enforce people to adapt to the standards. This should spread to other states for effective measures in reducing noise pollution in the country. All measures to reduce the noise pollution should be strictly followed.

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Ethical issues

The authors of this paper certify that all data obtained during the study are as stated in the manuscript, and none of the data has been or will be published separately elsewhere.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

All the authors contributed and are involved in the conceiving of the problem, the design of experiments, data collection, and article approval.

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