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# Effects of noise-induced hearing loss within Port Harcourt metropolis, Nigeria.

**[1]V. B. Omubo-Pepple, [2]C. Israel-Cookey, [3]G. I. Alaminokuma**
***[1,3]Department of Physics, Rivers State University of Science and Technology Port Harcourt, Nigeria,***
***[2]Department of Mathematics, Rivers State University of Science and Technology, Port Harcourt, Nigeria,***

***Abstract***

***This paper investigates the effects of Noise-Induced Hearing Loss within Port Harcourt Metropolis using a micro-controlled diagnostic audiometer (Kamplex KLD21).The data was obtained at two specific locations namely: Rivers State University of Science and Technology and Port Harcourt International Airport. The measurements showed that the highest noise intensity level at Rivers State University of Science and Technology is 120dB with noise- induced hearing loss of 35dB (air and bone conduction) at audiometric frequency of 4000Hz, while the airport has the highest noise intensity level of 107dB (air conduction audiometry) and 75dBA (bone conduction audiometry) at 4000Hz. The normal recommended hearing level is 5dBA at 4000Hz.These data confirm that many of the subjects tested at the two locations are affected by Noise-Induced Hearing Loss (NIHL)***

***Keywords***
Air conduction audiometry, Bone conduction audiometry, noise-induced hearing, impairment, Audiometry, Transducer.

## 1.0 Introduction

The perception of sound in day-to-day life is a major importance for human wellbeing. Communication through speech, sounds from playing children, music, natural sounds in parklands, parks and gardens are all examples of sounds essential for satisfaction in everyday life. Basically this study is related to the adverse effects of sound which is noise. According to the International Programme on Chemical Society, WHO in 1994 defined adverse effect of noise as a change in the morphology and physiology of an organism that results in impairment of functional capacity, or an impairment of capacity to compensate for additional stress, or increases the susceptibility of an organism to the harmful effects of other environmental influences. Ward [1] studied in detail the concept of susceptibility to hearing noise.

Noise-Induced Hearing Loss (NIHL) is the increase (or elevation) in the threshold of hearing. It is assessed by threshold audiometry which is the technique used in this study. Hearing handicap is the disadvantage imposed by hearing impairment which is sufficient to affect one's personal efficiency in the activities of daily living .NIHL results when an individual

**[1]Corresponding author**
**[1]e-mail: omubopepple@yahoo.com**
**[1]Telephone: 08030853010**

is exposed to harmful sounds that are too loud (100-140dB) over a long period of time: sensitive structures of the inner ear can be damaged causing Noise Induced Hearing Loss. Worldwide, NIHL is the most prevalent irreversible occupational hazard. In developing countries like Nigeria, not only occupational and industrial noise, but also environmental noise is an increasing risk factor for NIHL. In 1995, at the World Health Assembly, it was estimated that there are about 120 million persons with disabling hearing difficulties worldwide. Research has shown that NIHL can be significant at a steady-state noise level of (85-90dB). Impulsive sound can cause immediate hearing loss that may result in permanent threshold shift (i.e. permanent deafness). Menkiti [2], Krypter [3] studied the factors that constitute traffic noise and the effects of exposure to steady- state noise and impairment of hearing respectively.

NIHL (Occupational Induced Hearing Loss) is a long cumulative effect of noise that may lead to permanent changes for the worse in the hearing level of persons subjected to noisy environments in the course of their living or working over long periods. The effect of NIHL increases gradually over a period of continuous exposure to sounds which may become distorted or muffled to the ear and may be difficult for the person to understand speech. Very high impulsive sound can result in immediate hearing loss that may be permanent because the structures of the inner ear may be severely damaged. This kind of hearing loss may be accompanied by tinnitus- a ringing, buzzing or roaring in the ears or head which may subside over time. Hearing loss and tinnitus may be experienced in both ears, and tinnitus may continue constantly or occasionally throughout lifetime.

Temporary threshold shift is a short term effect and as its name indicates, the elevation is reversible. The effects of a particular noise exposure in terms of temporary threshold shift are dependent on individual susceptibility, age and heredity. Permanent threshold shift on the other hand, is used for conditions, which may have no possibility of recovery, Akhter [4]. Acoustic trauma is a condition of sudden ear damage resulting from short-term intense exposure or even from one single exposure; explosive pressure rise are often responsible, and these may arise from fire-works, small arms fire, gunfire or major explosions, Glorig and Davies [5].

Glorig et al [6] showed that persons exposed to high level of noise (84-98 dB)for about three hours daily in working conditions run high risk of NIHL in addition to cardiovascular disease and can develop hypertension five years earlier, under the same noise level.

Port Harcourt is classified under community noise because of its complex nature, since community noise (also called environmental, or residential or domestic noise) is defined as a noise emitted from all sources except noise at industrial workplace. The main sources of noise in Port Harcourt include road, rail, and air traffic, industries, construction and public work places. Indoor noises include ventilation systems, office machines, home appliances and neighbours.

Mechanized industry creates service noise problems. It is responsible for intense noise indoors as well as outdoors. Rotating and reciprocating machines generate sounds that include tonal components and moving equipment tends to generate noise with wide frequency range. The high sound pressure levels are caused by components or gas flows that move at high speed or by operation involving mechanical impacts (for example, stamping, riveting and road breaking). Building construction and evacuation works can cause considerable noise emissions. A variety of noise comes from cranes, cement mixers, welding, hammering, boring, etc.

Following the research carried out by Mulholland and Attenborough [10], official consideration is known to be taking place on both prevention of and compensation for, occupational hearing loss in Britain.

Transportation is the main source of environmental noise pollution in Port Harcourt. These include road, rail and air traffic. Aircraft operations generate substantial noise both commercial and military. Greatex [8] investigated the effects of take-off and landing of air crafts while Jerger [9] studied the control of sound, noise and vibration. The landing produces substantial noise in long low-altitudes flight corridors. In residential areas, noise may stem from mechanical devices (e.g. heat pumps, ventilation systems etc) as well as voices, much and all kinds of sound generated by neighbours (e.g. lawn mowers, vacuum cleaners and other household equipments, music production and noisy parties). Aberrant social behaviour is a well recognized noise problem in multifamily dwellings, as well as sites for entertainment (e.g. sports and music events). Due to predominantly low frequency components, noise from ventilation systems in residential buildings may also cause considerable concern even at low and moderate sound pressure levels. Severe hearing impairment may also arise from intense sound produced as music in headphones or from children's toys and cell-phone vibrations, Forrest and Coles [10].

For the first time a person works in a noisy environment where he or she is not use to, the person will suffer a temporary threshold shift which is accompanied by ringing in the ears known as Tinnitus. This effect may cause psychological effects like making the person tired. The person may further loose some degree of hearing unless the tolerable limit is not exceeded. However, depending upon the person's susceptibility, there may be a point of no return and eventually the person will have acute hearing problem. As the years go by the dip in his or her audiogram at 4 000Hz will deepen and then widen to drag down other frequencies with. The person will reach old age very deaf, Barden [11].

## 2.0 Methodology

The technique of measuring hearing loss is known as audiometry, and various forms of audiometry are used for different purposes. The simplest basic technique is Pure Tone Air Condition Audiometry in which the audiometer is controlled manually and the sound (pure tone) is presented to the ear by means of an earphone. In this method the minimum intensity of sound in the form of a pure tone which is audible (auditory threshold) is determined. Since the sensitivity of the ear is not the same for all frequencies in the audible spectrum, a threshold determination is necessary at a number of arbitrary frequencies. Each ear is tested separately. The threshold values obtained could be expressed, for example, as actual values of the sound pressure level presented to the ear and measured preferably at the ear drum.

The air and bone-conduction audiometries for the right and left ears were measured in each case. The Normal threshold of zero hearing which is the audiometric frequency at which the person tested can no longer hear a tone was also measured. The descending and ascending threshold of zero hearing which are techniques used to confirm that the person tested has reached his/her normal threshold of zero hearing were measured.

### 2.1 The pure-tone air-conduction audiometry

In the conventional form of audiometry, the essential requirement is that the person being tested should be presented with pure tones of known intensity level and at controllable intensity and frequency. The tones are generated by an electrical oscillator circuit capable of providing sine waves at a number of frequencies from which the operator selects more than one at a time for each threshold determination. While it is possible to perform these threshold determination by setting up a sound field of known intensity in which the subject is placed, this is not normally done, but earphone listening is the normal procedure.

The electrical output to the earphone is controllable by an attenuator, also under the control of the operator and the resultant sound generated by the ear phone can therefore be set at any desired value within the capacity of the instrument. Switching arrangements to give on-off control of the tone in a gradual manner, free from clicks other unwanted sounds, together with earphone selection for the right and left ears, provide the basic facilities for audiometry. The test must be done in a sufficiently environment to avoid masking of the audiometric tones by other sounds. The tones are applied by the audiometrician by operating the appropriate switch on the audiometer and should be about one second in duration. Usually, all that the subject has to do is to raise a finger, or press a button, which operates a light signal when he or she hears a tone.

## 2.2 The pure-tone bone-conduction audiometry

The Bone-Conduction Audiometry is supplementary to air-conduction audiometry in measuring the entirety of ear hearing mechanisms (starting with the external ear canal, middle ear and inner ear). The Bone-Conduction Audiometry consists of applying vibrations to the bones of the head by means of bone-conduction transducer, which takes the place of earphone ear-piece. The transducer is applied to the bone of the head and the latter is set into vibration. The vibration in the bone excites the cochlea to vibrate, so that a sensation of sound results, without normal intervention of the conductive mechanisms. This method tests the function of the inner ear. An abnormality between the difference in hearing levels by air-conduction and bone-conduction may indicate a defect in the ear's conductive mechanism.

## 2.3 Mathematical Modeling of NIHL

It is found that the Noise Induced Hearing Loss denoted as H can be associated with a high noise level for a short time or a lower noise level for longer time. Forrest and Coles [10] showed the extent H is related to the sound energy reaching the ear over a wide range of exposures. This sound emission is termed by Forrest and Coles as Noise Imission Level (NIL) which is the sum of the sound level and the logarithmic expression of the duration of the exposure. Noise exposure may therefore be expressed by;

$$E_A = L_a + 10\log t / t_o$$

where $E_A$ = A-weighted NIL

$L_a$ = Sound level in (dB) exceeded for 2% of the time

$t$ = Duration in years

$t_a$ = 1 year reference

However, due to large individual variation in susceptibility to NIHL, it is necessary to specify H in terms of statistical distribution, for each audiometric frequency in a noise exposed population.

The relationship between noise exposure and hearing loss can be described by an equation which encompasses audiometric frequency and the statistical distribution by incorporation of suitable constants. We adopt the model given by Bosan and Carpenter [12].

$$H_p = 27.5\left\{1 + \frac{\tanh\left(E_A - \lambda_f + U_p\right)}{15}\right\} + U_p$$

where $H_p$ = NIHL which is exceeded by $\rho$ percent of the population.

$E_A$ = A-weighted Noise Imission Level (HIL)

$\lambda_f$ = A constant depending on audiometric frequency.

$U_p$ = A constant depending on the selected percentage $\rho$.

## 3.0 Results and discussions

The more prevalent noise damages are from effects of continuous periods of exposure to high-intensity noise levels. These affect people in two ways; the first of which is not very harmful. For instance, if you are exposed to noise pressure level in excess of 90dB or more in the middle-to-high frequency range, for a few minutes, you will afterwards suffer what is known as a 'temporary threshold shift'. Exposure to a loud noise elevates the threshold level which is the lowest level at which one can start to hear a sound of a particular frequency. It is necessary to carry out hearing measurements in specially constructed rooms called anechoic chambers with very low ambient noise level, using headphones to transmit the test tones (sound) to the hearing system. This technique is audiometry and the result is a graph of the subject's hearing sensitivity level known as an audiogram.

The noise intensity level of sources within the University community as shown in Table 3.1 is not too high by Nigerian standards shown in Table 3.2 with exception of the intensity noise level from the generator set which is about 120dB. However, the people that operate the generator do not spend much time in the generator house and may not be exposed to serious ear damage.

**Table 3.1**: Main sources of environmental noise climate within RSUST community

| S/N | Location of source | Sound Pressure(dB) |
|---|---|---|
| 1. | Amphitheatre(outside) | 52-60 |
| 2. | Students' parliament building | 64-70 |
| 3. | Shopping complex | 70-80 |
| 4. | Taxi/bus car park | 78-90 |
| 5. | Air traffic (Main library) | 87-100 |
| 6. | Generator plant (Old site) | 40-120 |
| 7. | Convocation Arena (Outside) | 62-70 |
| 8. | Road traffic | 70-110 |

**Table 3.2**: Standard noise exposure limit in Nigeria

| S/N | Duration Per Day (hr) | Permissible Exposure Limit (dB)A |
|---|---|---|
| 1. | 8 | 90 |
| 2. | 6 | 92 |
| 3. | 4 | 95 |
| 4. | 3 | 97 |
| 5. | 2 | 100 |
| 6. | 1.5 | 102 |
| 7. | 1 | 105 |
| 8. | 0.5 | 110 |
| 9. | 0.25 or less | 115 |

The intensity noise levels from the aircrafts are outrageously high for people to be exposed to. Noise intensities from other sources generated within the airport were also recorded. For proper analysis of the noise generated in the Port Harcourt International Airport, a summary of the noise sources with percentage noise intensity within the environment are shown in Table 3.3. The average value for each of the aircraft was taken on take off and on landing.

Audiograms which are actual interpretations of individuals hearing system obtained by measuring the air and bone conduction audiometry responses of both the right and left ears are shown from Figures 3.1 to 3.6. The specialist in the field of acoustic audio logy uses the audiograms to classify human hearing systems as normal, partially impaired and very seriously impaired.

The results of the investigations show that audiograms of tests one and two are normal; three and four are partial impairment, while five and six are that of very serious but partially impaired. This very serious impairment can lead to total deafness if it is not treated early. Further, results of test five is typical of those working in riveting company.

**Table 3.3**: Summary of the noise levels from different sources in the Port Harcourt international Airport.

| S/N | Noise Source | Average Noise Intensity(dB) | %Noise Intensity |
|---|---|---|---|
| 1. | Virgin Nig. 5N-VNB(PH-LAGOS) | 95.30 | 5.43 |
| 2. | Virgin Nig. 5N-VNB(PH-ABUJA) | 105.50 | 6.01 |
| 3. | CHANCHANGHI 5N-BEW(PH-LAGOS) | 97.80 | 5.57 |
| 4. | CHANCHANGHI 5N-BEW(PH-ABUJA) | 105.00 | 5.98 |
| 5. | SOSOLISO5N-BGL(PH-ABUJA) | 95.40 | 5.43 |
| 6. | AERO 5N- BHY (PH-ABUJA) | 92.65 | 5.28 |
| 7. | AERO 5N- BHN (PH-LAGOS) | 95.35 | 5.42 |
| 8. | AERO 5N- BHW (PH-ABUJA) | 102.60 | 5.84 |
| 9. | DHL ZS-OVS (PH-LAGOS) | 92.75 | 5.28 |
| 10. | BELL VIEW (PH-LAGOS) | 85.50 | 4.87 |
| 11. | AIR FRANCE F-GZCM (PH-FRANCE) | 107.85 | 6.14 |
| 12 | LUFTHANZA D-AIFA (PH-GERMANY) | 100.50 | 5.72 |
| 13 | OCEAN I-OCEAN (PH-GERMANY) | 103.50 | 5.85 |

| | | | |
|---|---|---|---|
| 14 | ADC BEE (PH-LAGOS) | 87.750 | 5.00 |
| 15 | CAT GENERATOR | 96.33 | 5.49 |
| 16 | WATER PUMOING MACHINE | 97.00 | 5.52 |
| 17 | MOTOR TRAFFIC | 70.00 | 3.99 |
| 18 | HUMAN TRAFFIC | 55.00 | 3.13 |
| 19 | AIRPORT CLINIC | 71.66 | 4.08 |
| 20 | **TOTAL AVERAGE NOISE** | **17755.69** | |

The study showed that Port Harcourt International Airport is a heavily noise polluted environment while Rivers State University of Science and Technology community has a quiet ambient noise level with the exception of noise generated from generators and occasional fly-over of helicopters.

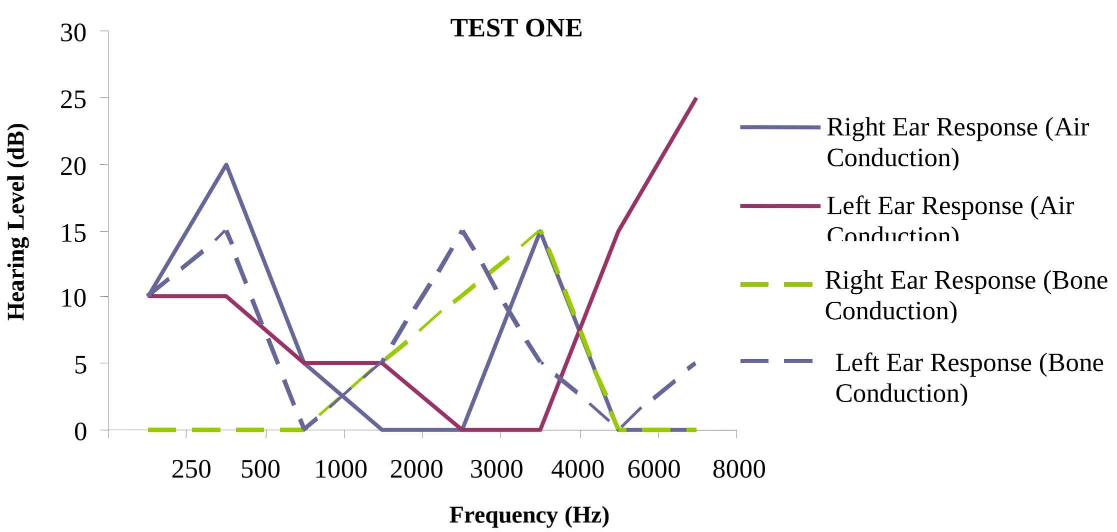


**Figure 3.1**: Air and bone conductions relative sensitivity curves.

Result from Figure 3.6b shows that the noise from the airport is both intermittent and continuous. Intermittent from landing and take-off of the aircrafts while the continuous noise source is from power generating sets and motor traffic.

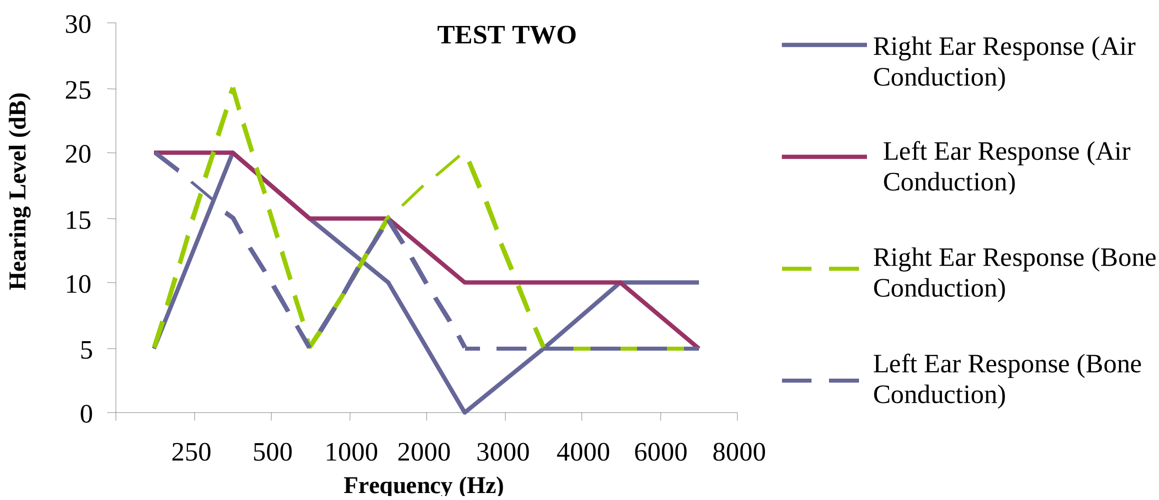


**Figure 3.2**: Air and Bone Conductions Relative Sensitivity Curves.

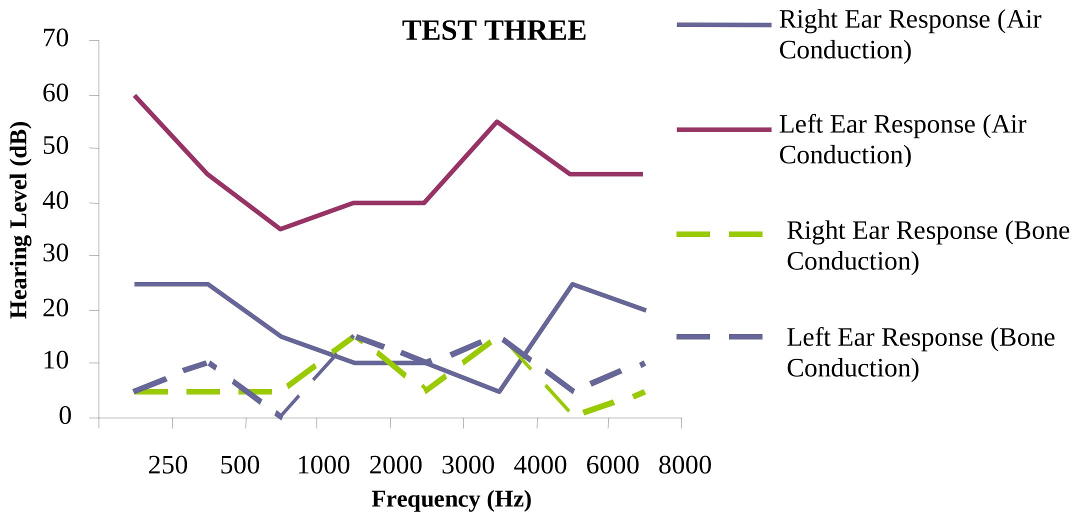


**Figure 3.3**: Air and bone conductions relative sensitivity curves.

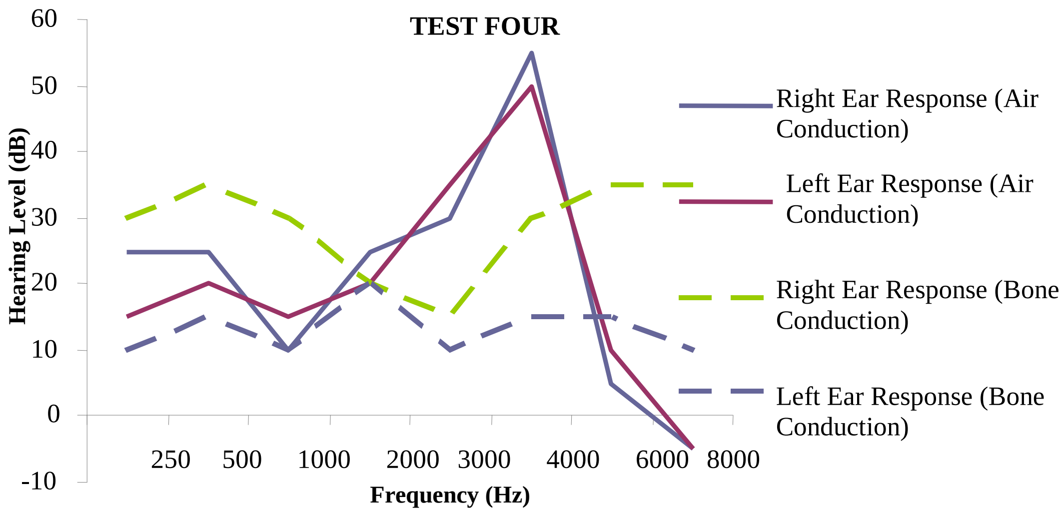


**Figure 3.4:** Air and bone conductions relative sensitivity curves.



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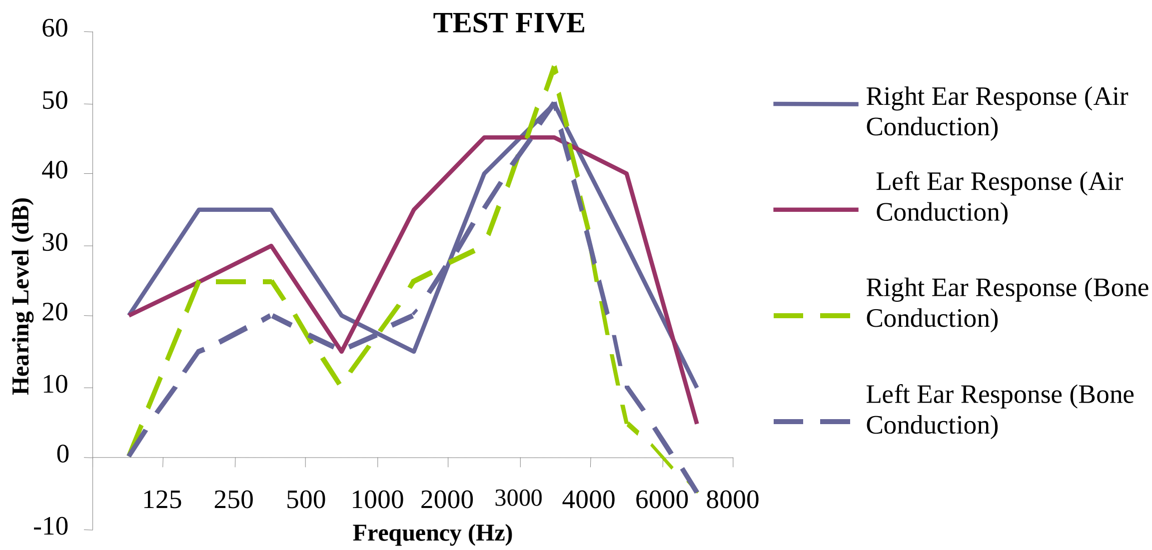


**Figure 3.5**: Air and Bone Conductions Relative Sensitivity Curves.

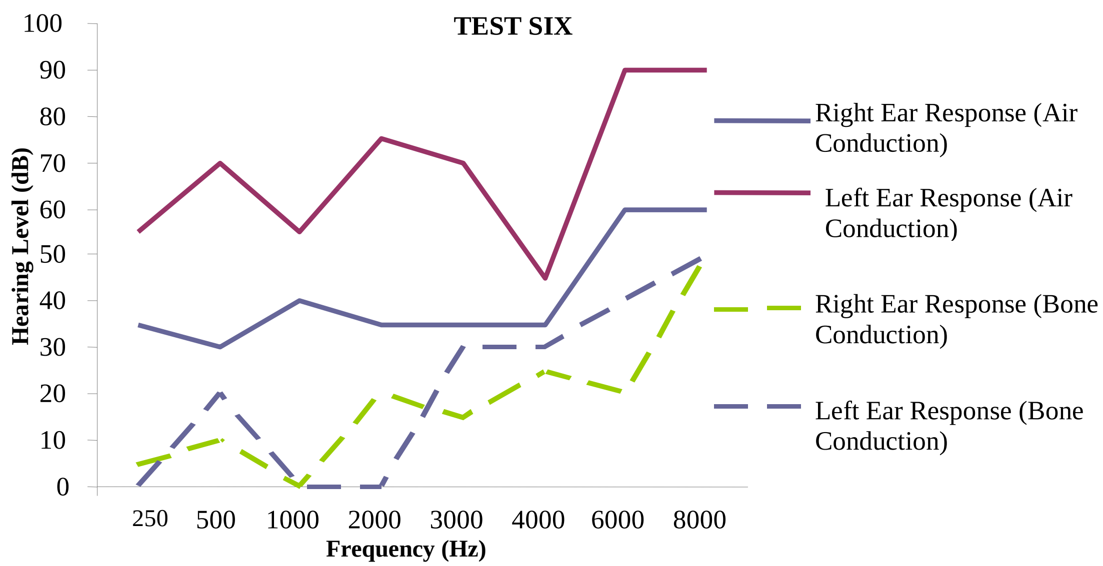


**Figure 3.6**: Air and bone conductions relative sensitivity curves.

## 4.0 Conclusion

This paper investigated the bad effects of noise, the Noise-Induced Hearing Loss which affects the human performance and efficiency at every level of human endeavour. In the study, two locations were chosen, Rivers State University of Science and Technology Community and Port Harcourt International Airport Community. The noise intensity levels of both communities were measured and result obtained showed that the Rivers State University of Science and Technology Community noise levels were comparatively lower than that of Port Harcourt International Airport Community. The later typified a heavily noise polluted environment while RSUST community is taken as quiet, ambient noise level with the exception of the noise generated from generators and occasional fly over of helicopters. The air and bone audiometries employed in this research give a three dimensional views of the NIHL status of the subject tested. Finally, the audiograms obtained will be useful in classifying a subject as having normal, partially impaired or very serious impaired hearing.

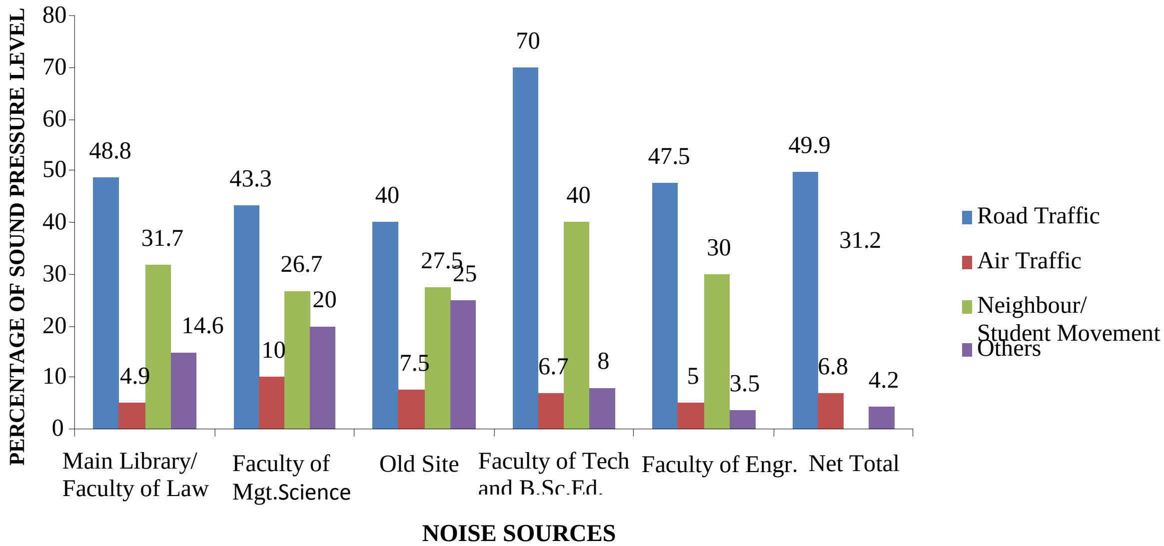


**Figure 3.6a:** Noise intensity levels within RSUST community**.**

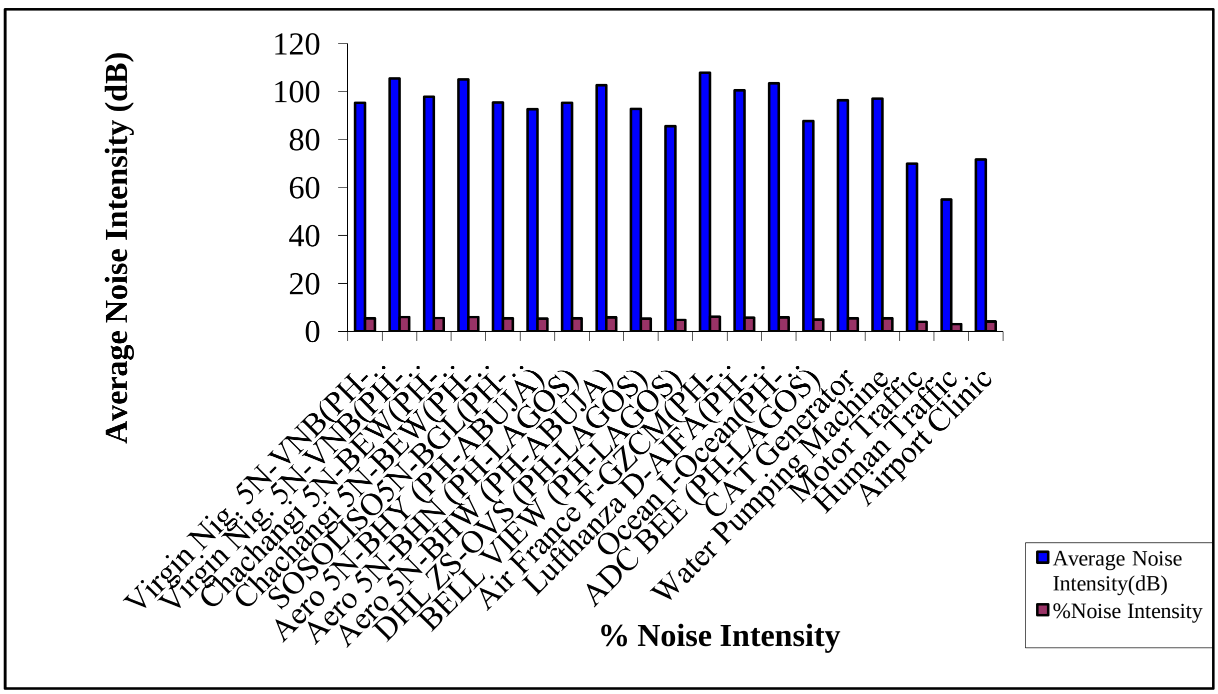


**Figure 3.6b:** Noise intensity levels within Port Harcourt International Airport.

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